AN ECONOMIC ANALYSIS OF FERTILITY IN JAPAN: WILL THE HUSBAND'S TIME SPENT IN HOUSEWORK AND CHILDCARE INCREASE BIRTH PROBABILITIES?

By

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DEDICATION

I dedicate this dissertation to my husband Jeff and our adorable daughter Yuki.

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This dissertation makes a theoretical contribution by incorporating the role of the husband's time spent in unpaid work on women's fertility decisions. A Stackelberg fertility model is developed which diverges from the existing literature in two ways. Firstly, the husband's perception of social norms about intra-household division of labor and the pressure to conform to these norms are determining factors in the husband's contribution to housework. Secondly, the husband's time contribution to housework increases his wife's demand for children in the subsequent period.

The dissertation also makes an empirical contribution by testing the hypothesis that the more the husband spends time in housework and childcare, the higher the birth probabilities and time specific birth probabilities. Using Japanese time use panel survey data, it finds that women decide to have their first child even when their husbands are unhelpful. While this result contradicts the hypothesis, husbands without children spend little time in housework to begin with which likely explains this result. For higher birth orders, the husband's time spent in housework increases the birth probability for the second child, but it

does not affect the birth probability of the third child. After examining inter-birth spacing, the dissertation finds that the husband's helpfulness affects the ultimate number of children women decide to have, but not the timing of births.

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CHAPTER 1

INTRODUCTION

1.1 Motivation

Japan’s fertility rate has been steadily declining since 1967. The fertility rate, at 1.34 in 2007, is one of the lowest in the world and is well below the replacement rate of 2.2 (Ministry of Health, Labor and Welfare 2008). This has gained attention and serious concerns among Japanese policy makers, academics and the public. Further, Japanese people are living longer[1] and having fewer children, which accelerates the process of an aging population. Japan’s aging population is higher than France, Germany, Sweden and the U.K (Shimasawa and Hosoyama (2004). By 2050, this is expected to: a) reduce Japan’s labor force to two thirds of its current size (Japan Institute for Labour Policy and Training 2006); and b) raise the proportion of seniors to 40 percent of the population (Ministry of Health, Labour and Welfare 2008).

The shrinking productive workforce therefore has to support an increasingly dependent population which affects the economy in several ways. Firstly, without a significant inflow of immigration, or an increase in labor productivity, the shrinking size of the workforce reduces the future growth prospects (Aoki 2004, Shimosawa and Hosoyama 2004). Secondly, an increasingly aging population puts a severe strain on the public pension and public health insurance schemes, a significant portion of which is already paid by the tax system (National Institute of Population and Social Security Research 2007). Currently, half of the public Basic Pension expenditures and a third of the public health insurance schemes are funded by the government (National Institute of Population and Social Security Research 2007). Thirdly, the number of elderly people that need nursing care is rising, and the burden of elderly care falls on women because of their socially assigned role to provide unpaid work. About half of the main providers of elderly care are women (namely wives, daughters, or daughters in law), compared to 17 percent of whom are men (Cabinet Office 2008).

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1. Japan’s life expectancy is 87 years for women and 79 years for men (Ministry of Health, Labour and Welfare 2005).

Studies in Japan have attributed the causes of low fertility to a number of factors. These include economic instability, women’s dissatisfaction towards their husband’s contribution to housework and the lack of public support to childcare (Ehara 2004, Meguro 2004). Between 1991 and 2000, the annual growth rate of GDP on average was 0.5 percent, which has come to be known as the lost decade (Hayashi and Prescott 2002). Based on a qualitative study drawn from conducting direct interviews with respondents, Meguro (2004) argues that women’s resistance to gender inequality in the home, especially in terms of an unequal division of labor, is one of the causes of lower fertility in Japan. One way for women to avoid facing additional physical and psychological burden is by refusing to have more children (Ehara 2004). Similarly, national surveys show that women who gave a higher rating on their husband’s performance in childcare were more likely to plan to have more children (National Institute of Population and Social Security Research 2003a, National Institute of Population and Social Security Research 2005). The surveys do not use a multivariate analysis; it is an estimate of the correlation between the wife’s rating of her husband’s performance in childcare and fertility plans for more children.

Since the time constraint is binding, if the husband’s time in housework affects fertility, we may expect the husband’s time spent in the labor market to affect fertility too. However, an empirical study by Zhang, Shichijo and Suruga (2001) finds that husband’s working hours do not affect fertility.[2] This finding further strengthens our argument for focusing our analysis on the husband’s time in unpaid work in women’s fertility decisions.

Beliefs about the gender assigned division of labor, that women should take care of the house and men should work outside of house, are prevalent in Japan. 44.8 percent of men and 39.8 percent of women believe that a wife should be a full-time home maker and the husband should work outside the home in Japan (Cabinet Office 2007). More men than women support this statement, and a higher percentage of older generation in their 40s and 50s agree with this statement than those in their 20s and 30s (Cabinet Office 2007). These figures are considerably higher than other countries, such as Sweden where only 8.9 percent of men and 4.0 percent of women believe in the gender assigned roles (Cabinet Office 2003). Further, 49 percent of respondents of the *Public Opinion on the State of a Gender Equal Society* (men and

2. Zhang, Shichijo and Suruga (2001) do not estimate the birth probability by parity.

women in total) think that men have to change their attitudes and reduce their resistance towards housework in order for them to fully participate in housework, childcare, elderly care and community work (Cabinet Office 2007).[3] In contrast, only 20.4 of respondents think that women's attitudes about men's role in housework have to change for men to participate more fully in these activities (Cabinet Office 2007). This implies that men's attitudes and values towards housework are important determinants of their contribution in unpaid work.

These studies highlight the role that gender norms play in the husband's contribution to housework, and the importance of the husbands' support in childcare and housework in fertility decisions. This is particularly crucial because Japan's public support for family policy is one of the lowest among developed countries and this could have eased the childcare burden placed on women (National Institute of Population and Social Security Research 2003b).[4] However, existing economic theory assumes that only women bear the full burden of housework and fertility decisions, and preferences can be summarized in a single household utility function (Becker 1991, Willis 1973). This approach in the literature has been criticized by Folbre (1988) for ignoring the conflicts that could arise in a household fertility decision. She also argues that social and economic inequalities could be a contributing factor to the declining fertility in developed countries, but existing economic literature ignores this by assuming that a couple's preferences can be summarized in a single utility function. Therefore, a new theoretical model is needed to incorporate the gender-assigned roles in determining the husband's contribution to housework and the role of the husband's unpaid work in women's fertility decisions. Further, an empirical analysis of the role of the husband's contribution to housework directly on observed births is needed to test the above hypothesis.

1.2 Objectives of the Dissertation

The dissertation has two main objectives, namely: to make a theoretical contribution by incorporating the role that the husband's contribution to unpaid work plays in women's fertility decisions; and to make an empirical contribution by examining whether the husband's time spent in unpaid work

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3. The survey result did not disaggregate the results by sex.

4. The ratio of expenditures for family policy to GDP is the second lowest among the OECD countries (National Institute of Population and Social Security Research 2003b).

affect birth probabilities and time specific birth probabilities using Japanese time use panel survey data. A Stackelberg model is developed that explores how social norms and the pressure to conform to these norms affect the husband's time allocation to housework, as the Stackelberg leader. The wife, as the follower, determines her demand for children based on her husband's time allocated to housework in the first stage. The model predicts that the higher the husband's time contribution to unpaid work, the higher the wife's demand for children in the subsequent period. Specifically, a testable hypothesis states that the husband's time spent in housework and childcare increases the probability of having children in subsequent periods.

This dissertation tests whether the husband's time spent in housework has an effect on whether a birth is observed or not, using a multivariate analysis. We use the time-use records by women and men allocated to housework and fertility information in the 1993-2004 *Data* from the *Japanese Panel Survey of Consumers* (12 waves) by Japan's Institute for Research on Household Economics. We estimate birth probabilities in two different ways. In the first approach, we ignore the spacing of births, and estimate the lagged husband's time in housework on the probability of having a child in the subsequent period. A pooled Instrumental Variable (IV) Probit model is used to estimate the husband's time in housework in the first stage and to examine its effect on the probability of birth in the second stage. We examine each parity separately. In the second approach, we estimate the timing of birth by measuring the impact of the husband's time in housework on the time-specific birth probability using a duration model.

1.3 Contribution of the Dissertation

Existing theoretical literature on fertility decisions assumes that the husbands play no role in housework or childcare, and that individual desire and preferences can be summarized in a single household utility function (Becker 1991, Francesconi 2002, Heckman and Walker 1990, Hotz and Miller 1988, Willis 1973). But these assumptions seem to contradict findings from Japanese studies which suggest that women react to the lack of support from their husbands in housework by refusing to have more children. Hence, new theoretical models are required to analyze the role of intra-household division of labor on fertility decision. This dissertation makes a theoretical contribution in two ways. Firstly, we incorporate the role that the husband's perception of social norms and the pressure to conform to these norms play in the husband's time allocated to unpaid work. Persistent beliefs about gender assigned roles on the division of labor could originate from the husband's childhood environment such as the region he grew up, or the social environment in he currently lives. Secondly, we explore the impact of the husband's time in unpaid work on the woman's fertility decisions. Therefore we formally analyze how social norms and the pressure to conform impact the husband's time allocated to unpaid work, which in turn affect the woman's fertility decision.

The dissertation makes the following empirical contribution. Firstly, it examines the impact of unpaid work on fertility decisions using Japanese panel data. The only other empirical paper that explores unpaid work and fertility is by Hotz and Miller (1988) who analyze the impact of women's time in childcare on fertility using U.S. data.[5] However, they do not investigate the effect of the husband's time spent in unpaid work on fertility decisions. Secondly, we use a multivariate analysis in estimating birth probabilities. The fertility studies and surveys analyzing the husband's unpaid work on fertility decisions in Japan so far do not isolate the effect of the husband's unpaid work from other factors such as education and income that could also affect unpaid work. Thirdly, parity specific birth probabilities are estimated in this dissertation. Fertility studies in Japan do not distinguish the birth probability of the birth order of the child. Factors affecting each birth order may be different and is more appropriate in a developed country context (Hotz *et al* 1997). For example, considerations for having the first child may be different from those that determine having the second child.

1.4 Outline of the Dissertation

The dissertation is organized in the following way. Chapter 2 discusses the background on population projection, fertility trends, marriage and labor force participation in Japan. Chapter 3 reviews the literature on fertility decision-making and time allocation decisions. The limitations of the existing literature in analyzing time allocation and fertility in Japan are highlighted. The Stackeberg model studying the effect of husband's contribution to housework on fertility decisions is developed in Chapter 4. Comparative static exercises are shown to highlight the effects of social norms and pressure to conform to these norms on the husband's time allocation decision, and its impact on the woman's fertility decision. Chapter 5 presents the data, tests of selection bias and attrition and the empirical methodology to test the

5. Hotz and Miller (1988) use women's time spent in childcare for one year.

hypothesis that the husband's time in housework and childcare increase the probability of having a child in the subsequent periods. The empirical results from the IV Probit model and duration model are presented in Chapter 6. The conclusion in Chapter 7 discusses the implications of its findings.

CHAPTER 2

BACKGROUND

This chapter provides the background on the projected population, fertility trends and regional differences, marriage and labor force participation in Japan.

2.1 Projected Population

The declining fertility is expected to cause three major demographic changes: reduce the total size of the population and the total workforce, and to increase the proportion of the elderly. The population growth rate was at zero percent in 2006 and is projected to turn negative thereafter (Institute of Population and Social Security Research 2009). Japan's population size in 2005 is 127.77 million, including non-Japanese residents (Institute of Population and Social Security 2009). Figure 2.1 provides a projection of the size of population from 2005 decreasing by 26 percent to 95.15 million in 2050 calculated by the Institute of Population and Social Security Research in 2006 using the medium variant of fertility rate and mortality projections (Institute of Population and Social Security Research 2009).[6] Worst still, the size of the working population is expected to fall 42 percent from 84 million in 2005 to 49 million in 2050, while the elderly population (age 65 or above) is projected to grow 46 percent from 26 million to 38 million during the same period. Taken together, the population profile will change from a barrel shaped figure in 2005 (with the working population being the largest group) towards an inverse pyramid shape by 2050 where the proportion of seniors edges closer to that of the working population.

The change in population by age group will result in the proportion of the elderly to rise significantly from 20.2 percent in 2005 to 40 percent in 2050 as shown in figure 2.2 (Institute of Population and Social Security Research 2009). The proportion of the working population will fall from 66 percent to 52 percent in the same period.

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6. The calculations are based on assumptions made about fertility rates derived from estimated age of first marriage, proportion of never-married population, marital fertility and divorce and remarriage rates (Kaneko *et al* 2008).

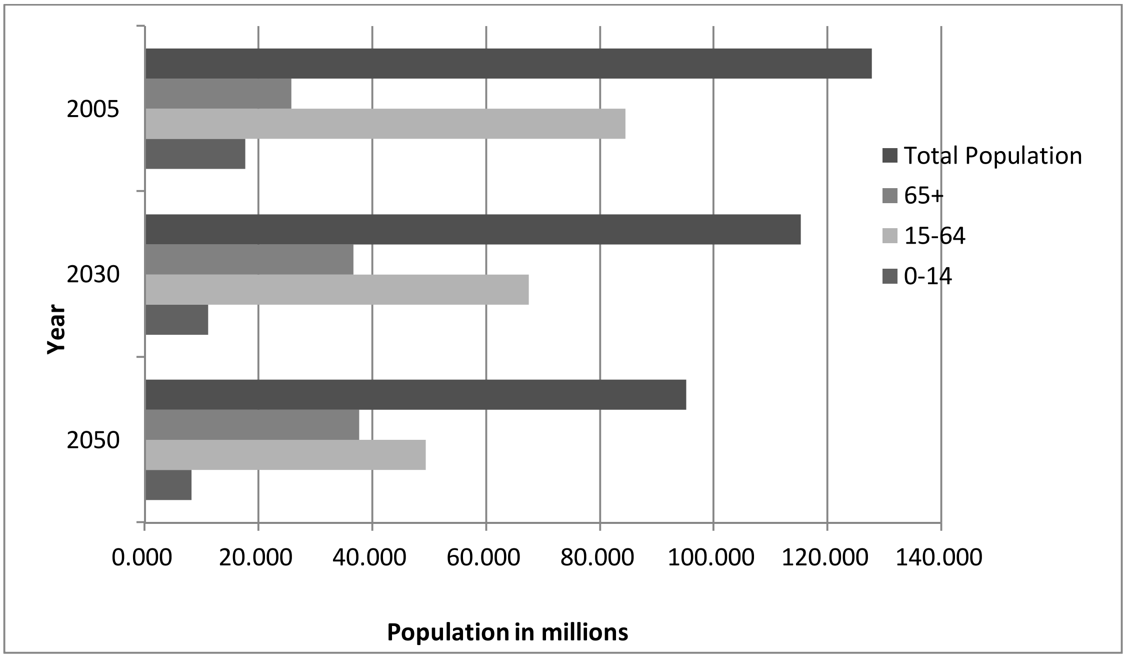

Figure 2.1. Projected Population by Age Group in Japan: 2005-2050. *Note:* Adapted from National Population and Social Security Research 2009. For Example, the Medium Variant Fertility Projection Use Fertility Rates of 1.26 for 2005, 1.24 for 2030 and 1.26 for 2050, and the Medium Mortality Projection Use Men and Women's Life Expectancy Of 78.5 and 85.5 in 2005, 81.9 and 88.7 in 2030 and 83.4 and 90.1 in 2050 (Kaneko, Ishikawa, Ishii, Sasai, Iwasawa, Mita And Moriizumi 2008).

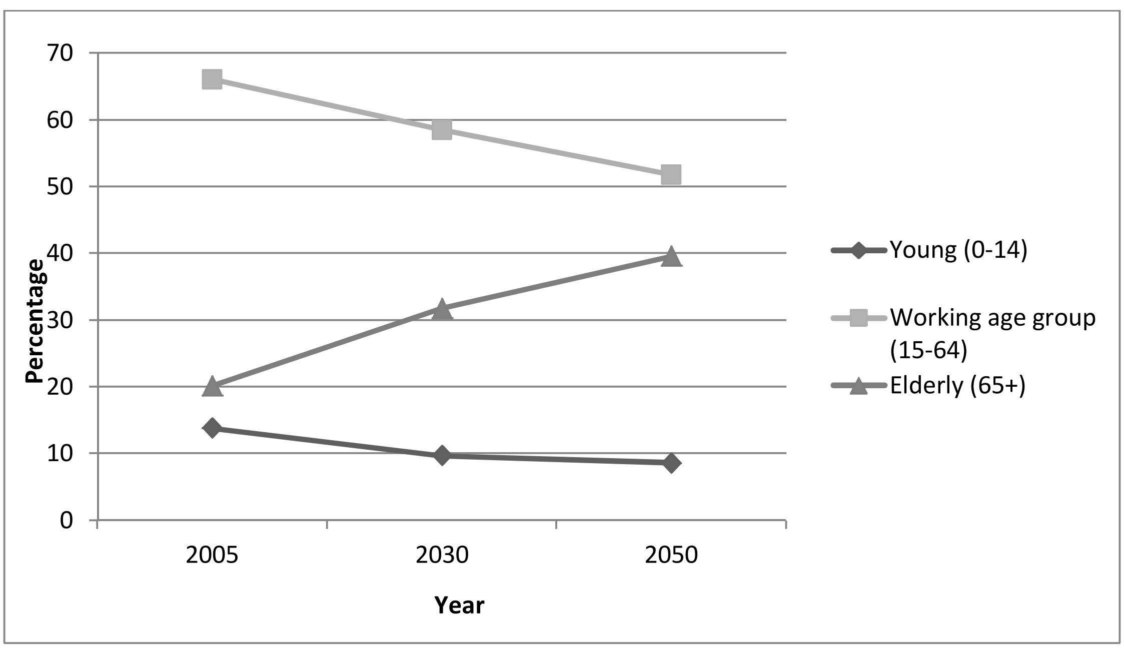

Figure 2.2. Proportion of Population by Age Group: 2005-2050. *Note:* Adapted from National Population and Social Security Research (2009).

Japan maintains a policy of restricting foreign labor into the country. As of 2008, there are 2.22 million registered foreigners in Japan which is about 1.74 percent of the total population (Ministry of Justice 2009).[7] Chinese represents the largest group among the foreigners with 655,377 people and 29.6 percent of the total registered foreign population in Japan (Ministry of Justice 2009). About 22.2 percent of the registered foreigners, or 492,056 people have a permanent resident status (Ministry of Justice 2009). Majority of those with permanent resident status are migrants of Japan's former colonies and their descendants (Kashiwazaki and Akaha 2006). In recent years, it began to permit some categories of skilled labor into Japan, particularly in the medical field such as doctors and nurses, as a result of growing labor shortages caused by the demographic changes (Kashiwazaki and Akaha 2006). However, even among the skilled workers, it is difficult to obtain permission to stay for a long term. For example, foreigners entering into Japan in the medical field have to pass the national exams conducted in Japanese. Only three out of 600 nurses from the Philippines and Indonesia have passed the nursing exam since 2007 (New York Times, January 2nd, 2011). It is clear that relaxing its immigration policy is unlikely to be used to alleviate the shrinking population and worsening labor shortages.

2.2 Delayed Marriage and Increase in Nonmarriage in Japan

The rise in the age of first marriage since the 1970s is cited as one of the reasons for the declining fertility rate as the birth rates for women in their 20s have been steadily declining and the proportion of young unmarried women and men has been increasing (Ministry of Health, Labour and Welfare 2006). The proportion of men and women in their 20s and 30s who are married from 1970 to 2005 is shown in figures 2.3 and 2.4, respectively. This is particularly important since births occur mostly within married couples, and non-marital fertility is very low representing only 1.6 percent of all births in 2000 (National Institute of Population and Social Security Research 2003b). In 1970, 10 percent of women and 12 percent of men between the ages of 30-34 were not married. These figures increased to 32 percent of women and 47 percent of men who were unmarried in 2005 (National Institute of Population and Social Security Research 2009). The average age of first marriage is 29.4 years old for women and 31.1 years old for men (National

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7. Registered foreigners exclude foreigners whose visas have expired.

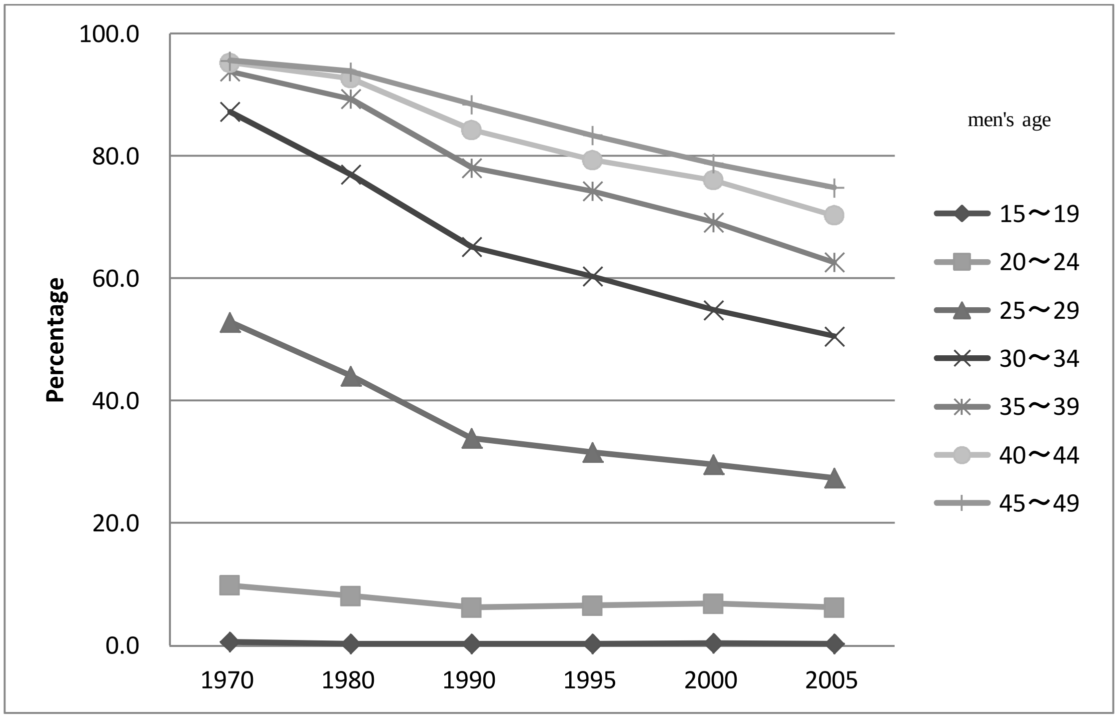

Figure 2.3. Percentage of Married Men by Age Group: 1970-2005. *Note:* Adapted from National Institute of Population and Social Security Research (2009).

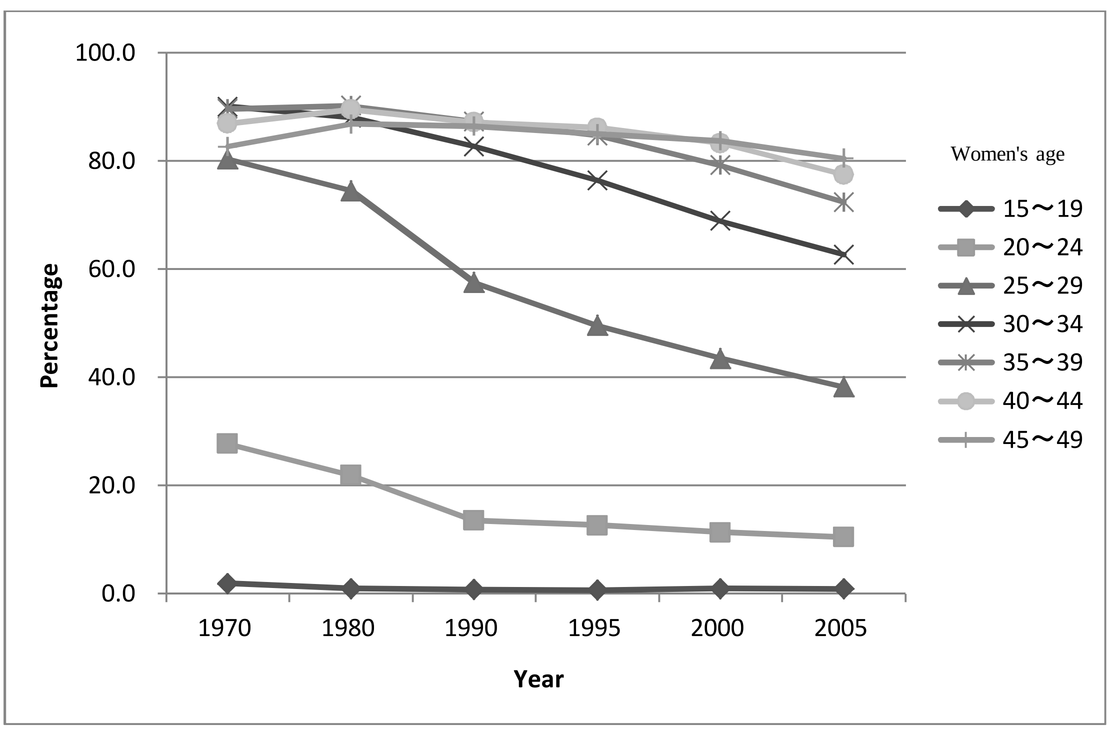

Figure 2.4. Percentage of Married Women by Age Group: 1970-2005. *Note:* Adapted from National Institute of Population and Social Security Research (2009).

Institute of Population and Social Security Research 2009). The increase in age of first marriage is likely to reduce fertility rates.

2.3 Fertility Trends in Japan

Over the last 30 years, the number of children among married women has been declining as shown in figure 2.5. By age 45 and above, the total number of children married women have has fallen from 2.7 in 1972 to 2.15 in 2005. Women in their 30s and late 20s are expected to follow this trend since they are also having fewer children. The large decline in the number of children in the late 20s and early 30s is partly caused by delayed childbearing. Between 1987 and 2005, the average number of children married women between 30-34 and 35-39 declined by about 0.5 and 0.33 respectively. The women's average age at first birth has been steadily increasing from age 26.6 in 1983, 27.4 in 1993 to 28.9 in 2003 (Ministry of Health, Labour and Welfare 2004).

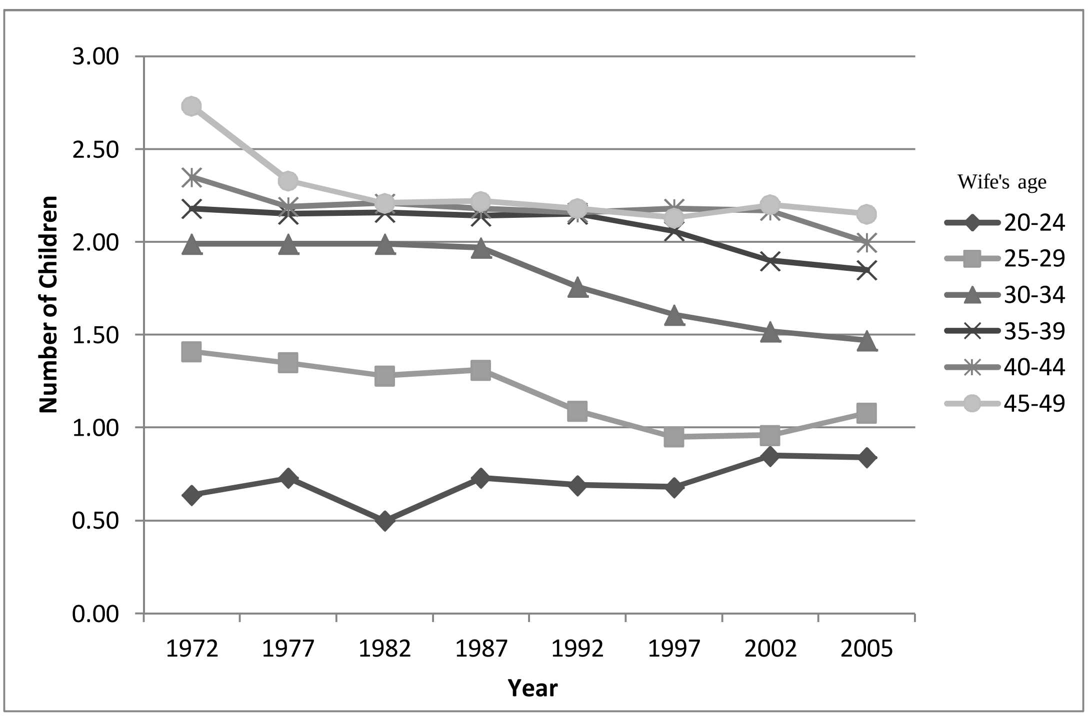

Figure 2.5. Average Number of Children among Married Women by Age. *Note:* Adapted from Fertility Surveys 1972-2005[8] by National Institute of Population and Social Security Research (2009).

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8. The figures are for couples whose wife is 50 years old or younger (National Institute of Population and Social Security Research 2009).

There is a growing trend for couples to stop having children after the first or second child is born, as the proportion of one-child couples is rising and the proportion of three children couples is declining (National Institute of Population and Social Security Research 2005).[9] From figure 2.6, among couples married for a duration of 15 to 19 years, the percentage of couples with three children have fallen from 27.4 percent to 22.4 percent between 1982 to 2005, while the proportion of childlessness has risen from 3.1 percent to 5.6 percent. The percentage of couples that stop after one child increased from 9.1 percent to 11.7 percent. These have caused the completed number of children for these couples to decline from 2.23 to 2.09 between this period (National Institute of Population and Social Security Research 2005). The declining trend in the average number of children is also exhibited in couples with a marriage duration of 5-9 years and 10-14 years (National Institute of Population and Social Security Research 2005).

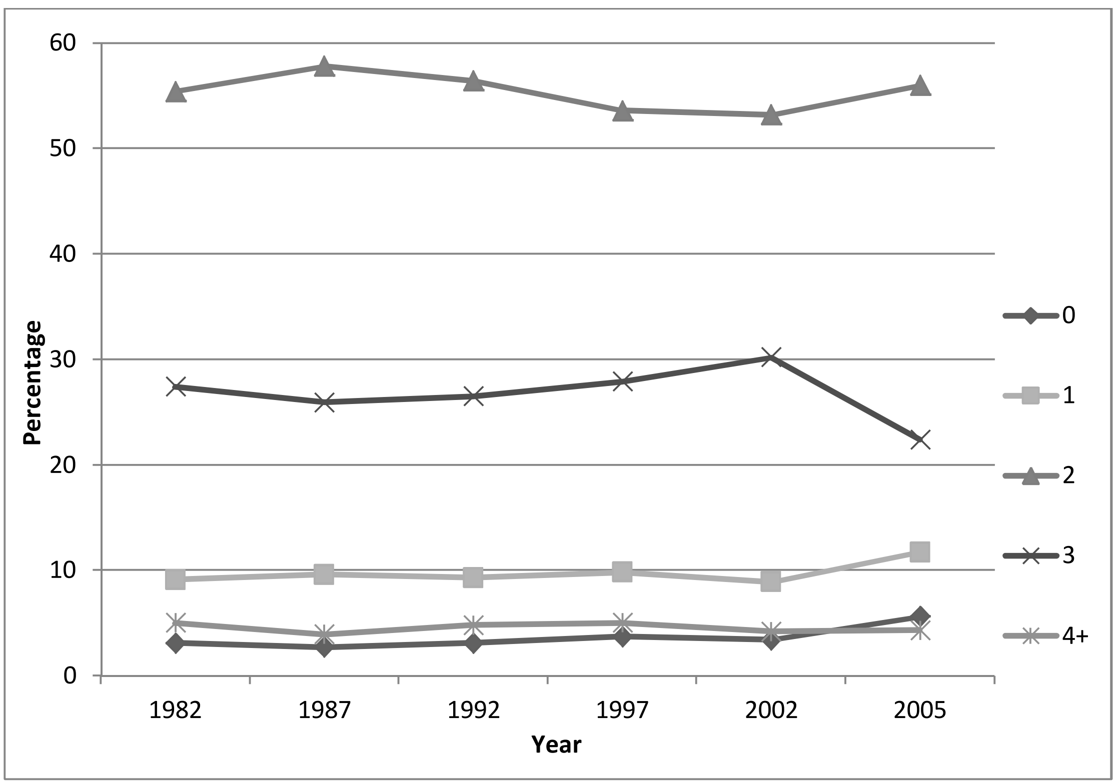

Figure 2.6. Percentage of Couples Married for 15 To 19 Years by Number of Children: 1982-2005. *Note:* Adapted from National Institute of Population and Social Security Research (2005).

9. A fertility and marriage survey on married women under the age of 50 is conducted every five years (National Institute of Population and Social Security Research 2005).

Despite the decline in the number children couples have, it does not seem to be due to the lack of demand for children. Atoh, Kandiah and Ivanov (2004) show that the ideal number of children women want, and the total number of children women intend to have remained stable at 2.6 and 2.2, respectively since 1975.

So what could explain the reasons why women are not having as many children as they would ideally want to have? The desired number of children women would like to have are substantially lower than the existing number of children (National Institute of Population and Social Security Research 2005). Women attribute the reasons for not being able to achieve the desired number of children to the lack of financial resources, the psychological and physical burden of children, the lack of support from their husbands in housework and the inability to balance work and family (National Institute of Population and Social Security Research 2005). The results disaggregated by age group are shown in figure 2.7.

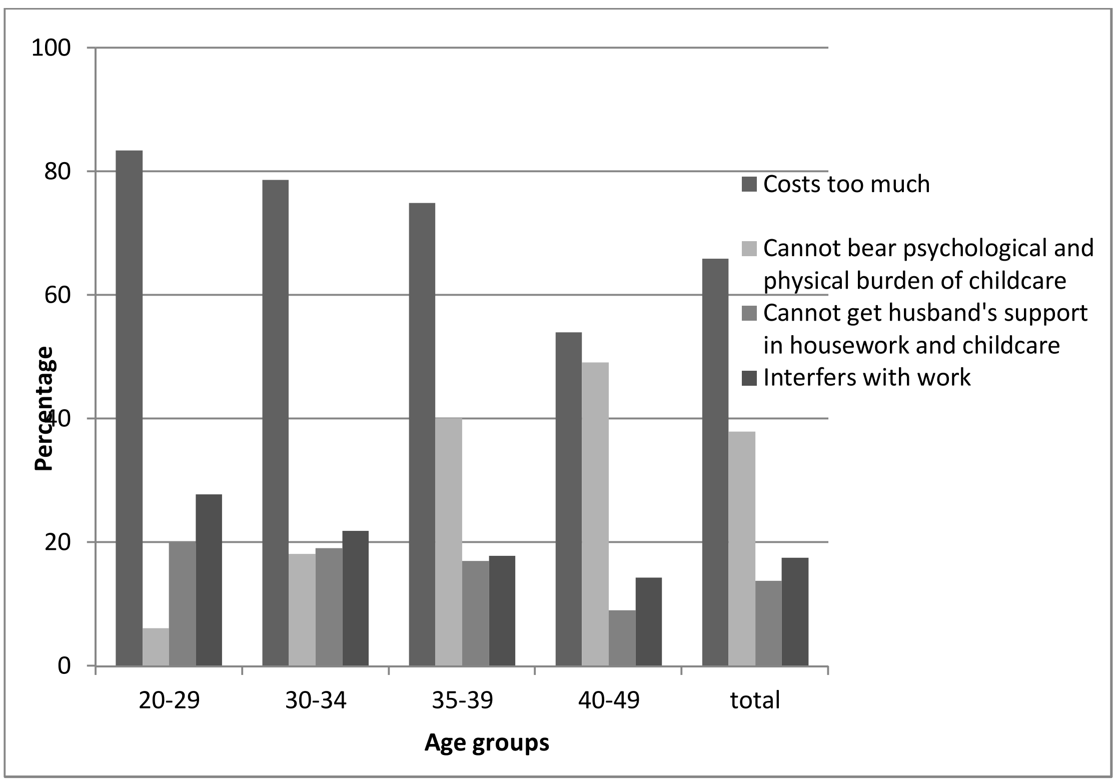

Figure 2.7. Reasons for Not Having Children.[10] Adapted from National Institute of Population and Social Security Research (2005). Respondents Can Select Multiple Answers.

10. Among couples whose desired number of children is below the planned number of children (National Institute of Population and Social Security Research 2005).

Among women who have not reached their desired number of children, approximately 20 percent of those between ages 20 to 39 cite the insufficient husband's contribution to housework and childcare as one of the reasons. 40 percent of women aged 35-39 and 50 percent of women who are 40 or older report that the psychological and physical burden of childcare as a reason for not having children. These two factors are actually closely related. Matsuda (2006) argues that husband's support in housework reduces the wife's psychological burden and anxiety in raising children and increases the wife's desire to have more children.

Koba, Yasuoka and Urakawa (2009) study the effect of the husband's contribution to housework on the women and men's desire to have an additional child using 2004 cross section data. They define the husband's contribution to housework as the number of times the husband undertook a housework activity in a week such as cleaning, washing dishes, laundry, looking after children as a proportion of the number of times the wife and husband under took the activities in a week. They do not distinguish between the birth order of the additional child. They find that the husband's contribution to housework has a positive effect on the wife and husband's desire to have an additional child. Although they do not study the effect on observed birth events due to the limitation of using cross-sectional data, the authors conclude that the desire to have an additional child is likely to lead to more observed births. This indicates that the husband's support in unpaid work is likely to reduce the wife's psychological burden of childcare and increase her desire to have another child. Therefore the question of who bears the childcare burden is an important factor in fertility decisions. It gives support to Folbre's (1988) argument that the crisis of care is a crucial component of the declining and aging population in developed countries.

Similarly, a panel survey conducted for women and men ages 20 –34 between 2002-2005 (4 waves) finds that the husband's time spent in housework and childcare on a non-workday has a positive correlation with the likelihood of the couple having a second child (Ministry of Health, Labour and Welfare 2005). But it does not have a significant relation with the probability of having a first or third child. Although the survey does not control for other factors since it is a comparison of the mean values, there is growing evidence from different sources that husband's support could be an important factor affecting fertility decisions in Japan. In Chapter 5 of this dissertation, using a different panel survey, the descriptive statistics also reveal that the husband's time in housework and childcare has a positive relation with the probability of having a second child, but it is insignificant for the first and third child. We plan to extend the analysis further in chapters 5 and 6 in the empirical analysis.

2.4 Women's Labor Force Participation and Fertility

Women's labor force participation in the working age group (15-64) was 61.7 percent in 2008 (Ministry of Labor, Health and Welfare 2008a). About 67 percent of women were in the labor force before they had their first child, but 62 percent of these women leave the labor force after the first child is born (National Institute of Population and Social Security Research 2005). This means that only about 42 percent of women stay in the labor force when their first child is less than one year old, and this proportion has remained relatively constant since the late 1980s (National Institute of Population and Social Security Research 2005). Women tend to leave the labor force when their children are young, and this causes the women's labor participation rate to dip during their reproductive years, especially in their 30s. They then rejoin the labor force in their 40s, coinciding with when their children are older, creating a M-shaped profile by age as shown in figure 2.8.

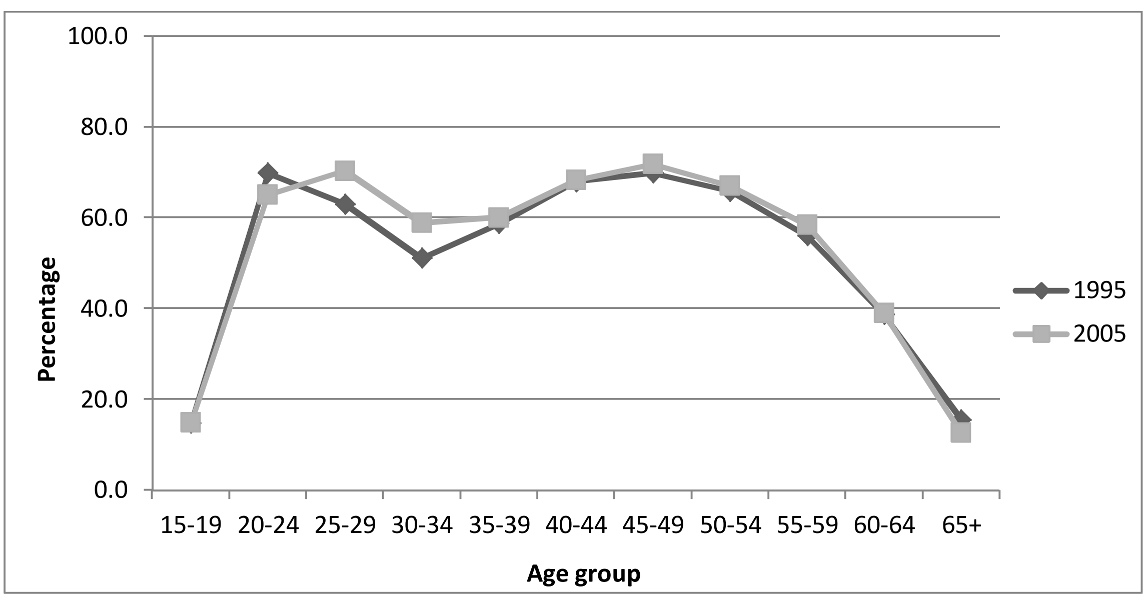

Figure 2.8. Women's Labor Force Participation Rate by Age in 1995 and 2005. *Note:* Adapted from Statistics Bureau, Ministry of Internal Affairs and Communications 2008.

Women's labor force participation rate starts to drop at an older age bracket in 2005 (which is the 25-29 age group) than in 1995 (which is the 20-24 age group) since women are having their first child at an older age. In 2005, the participation rate does not dip as much as in 1995 during women's reproductive age (20 and 49). The lowest labor force participation rate is 58.8 percent for the 30-34 age group in 2005 compared to only 51.1 percent for the same age group in 1995.

Women who are university graduates have a higher labor force participation rate than junior or senior high school graduate women in their 20s, but their participation rate dips during childbearing age, and they are less likely to return to the labor force thereafter (Ministry of Labor, Health and Welfare 2008a). Therefore the labor force participation rate of university graduates is lower than that of high school graduates when they are in their 40s (Ministry of Labor, Health and Welfare 2008a). The labor force participation rate of women university graduates has been described as a "giraffe" shape because it peaks in the 20s but it dips during childbearing age (during the early to mid-30s) and then it flattens out in their 40s (Ministry of Labor, Health and Welfare 2008a). This tendency was more prevalent in 1987 than it was in 2007 because in recent years, women tend to marry later and have children at an older age shifting the age at which the participation rate dips to an older age for university graduates (Ministry of Labor, Health and Welfare 2008a).

Nevertheless, women who are university graduates continue to work fewer years than high school graduates. The average number of years that female university graduates who are full time workers and who continuously worked is only 6.1 years compared to 9.7 years for high school graduates, despite the fact that 80 percent them would want to continue working (Ministry of Labor, Health and Welfare 2008a). This tendency is found in junior college graduates too. Using a probit model estimating women's labor participation in 1991, Yamashita (1999) finds that women who are graduates of junior colleges are less likely to be in the labor force than women who are high school graduates.[11] Date and Shimizutani (2004) argue that this could be because women who are more educated are less likely to rejoin the labor force once they had been out of the labor force after childbirth.

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11. University graduates do not have a significant effect on women's labor force participation (Yamashita 1999).

Among women who want to work but are not actively looking for work (i.e. discouraged workers), 44.2 percent of women university graduates are not looking for work because they are unable to balance work and childcare (Ministry of Labor, Health and Welfare 2008a). This figure for high school graduates is 23.0 percent (Ministry of Labor, Health and Welfare 2008a). This highlights the difficulty in continuing to work after childbirth and it is especially difficult for more educated women. University graduate women are more likely to work in regular staff positions as a percentage of those in the labor force than high school graduates (Ministry of Labor, Health and Welfare 2008a). But being a regular staff requires working long hours, performing overtime work unexpectedly and relocating to different cities (Nagase 2004). These conditions make it hard, especially for more educated women, to balance work and childcare.

One way for women to continue working after childbirth is to take paid maternity leave. Women and men are eligible to take maternity leave for up to one year if they work as regular staff, temporary staff or part-time worker as long as: they have been working in the current workplace for at least a year; they are likely to continue working after the child is one year old; and are enrolled in the employment insurance scheme (Ministry of Health, Labour and Welfare 2010a). If the workplace does not have a paid parental leave system, the government will pay approximately 60 percent of the salary for the first four months and about 30 percent of salary thereafter (Ministry of Health, Labour and Welfare 2010a). If the husband and the wife decide to take parental leave, they are eligible to expand the leave to 1 year and 2 months (Ministry of Health, Labour and Welfare 2010a).

However, studies have shown that small to medium size companies, especially those with less than 300 workers, are less likely to have a maternity leave system and women who work for these companies are less likely to take paid leave (The Japan Institute for Labour Policy and Training 2009). Almost all companies with 500 or more employees have maternity leave system, while 88 percent of companies with 100 to 499 employees have maternity leave system (The Japan Institute for Labour Policy and Training 2009). 80 percent of companies with 50 to 100 employees have a maternity leave system. This number drops significantly for companies with less than 30 employees where only 33 percent have maternity leave system. Only 32.4 percent of women working for companies with 300 or more employees took maternity leave and this figure falls rapidly the smaller the size of the company (The Japan Institute for Labour Policy and Training 2009). The figure is 22.5 percent and 4.8 percent for women working for companies with 100-299 employees and 30-99 employees, respectively (The Japan Institute for Labour Policy and Training 2009). The inability to take maternity leave, especially for small to medium size companies, is likely to discourage women from have children. Therefore a review of the maternity leave system, particularly for small to medium size companies is a challenge to addressing declining fertility.

On the men's side, only 1.72 percent of men take paternity leave even though 30 percent of men would like to take paternity leave (Ministry of Health, Labour and Welfare 2010). The inability to take paternity leave is also likely to discourage women from having more children as they cannot get the support from the spouses.

When women rejoin the labor force once their children are older, they are more likely to work as non-regular staff (defined as part-time[11] or dispatched staff, excluding executives and those engaged in farming), and this ratio has increased since 1995 as shown in figure 2.9. In their mid-40s, 55.9 percent of women in the labor force worked as non-regular staff in 2004.

What explains the high proportion of working women in non-regular jobs? On the labor demand side, part-time workers are a cheap source of labor because they often do not pay benefits (Ministry of Health, Labour and Welfare 2006c). Further, once you have been out of the labor force, it is difficult to find a regular full time job. 24.5 percent of women part-time job-holders[12] work part-time because they could not find a regular full time job (Ministry of Health, Labour and Welfare 2006c). Even when they are university graduates, over 40 percent of non-regular job-holder women in the 35-49 age group work in administrative jobs (Ministry of Labor, Health and Welfare 2008a).

On the labor supply side, women work part-time because of household responsibilities and childcare. 52.7 percent of women working part-time do so because of the flexibility in choosing the day they want to work (Ministry of Health, Labour and Welfare 2006c). While on surface, it appears that women willingly work part-time jobs, Tanaka (2004) argues that because of persistent gender assigned roles in housework, women do not have the option to work full time even if they wanted to. The gender

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12. Part-time workers are defined as those who work less than the regular workers in their work place (Ministry of Health, Labour and Welfare, Japanese Government 2006c).

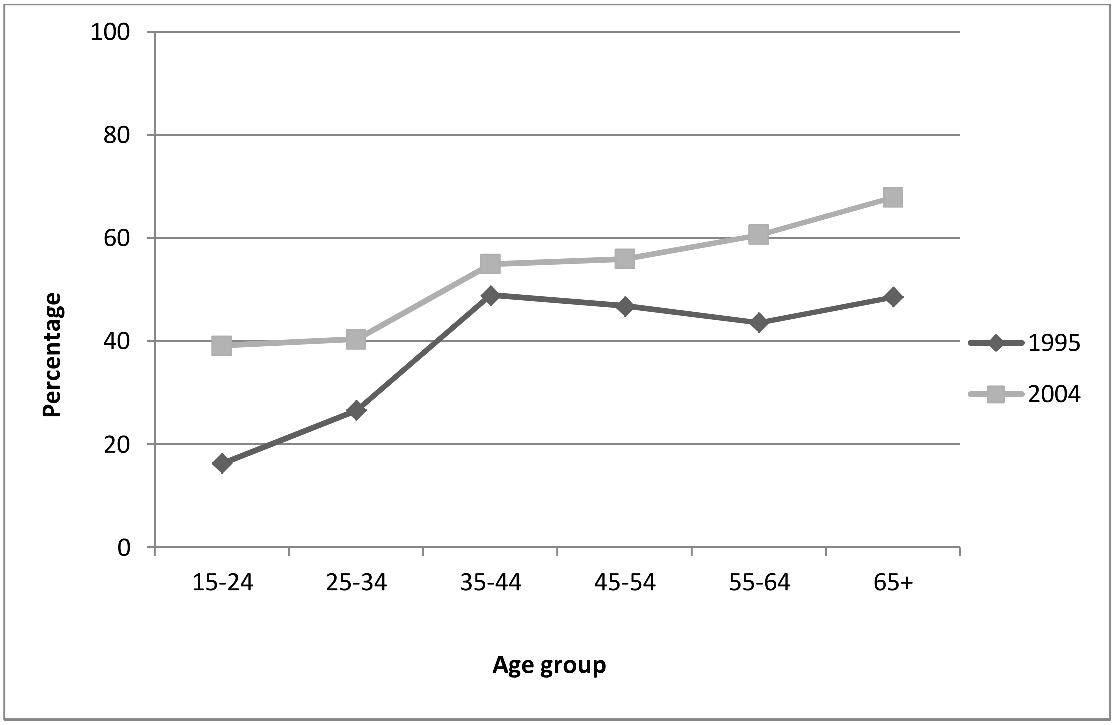

Figure 2.9. Women’s Ratio of Non-Regular Staff as a Proportion of Women in Labor Force in 1995 and 2004. *Note:* Adapted from Japan Institute for Labour Policy and Training (2006). Nonregular Staff Is Defined As Those in Part-Time[13], Affiliated, Dispatched Workers, Excluding Executives and Those Engaged in Agricultural Work (Japan Institute for Labour Policy and Training 2006).

assigned norms and responsibilities in the division of labor are still prevalent in Japan. 44.8 percent of men and 39.8 percent of women believe that men should work in the labor market and women should be a fulltime home-maker, and these figures are higher than other developed countries (Cabinet Office 2007).

Another important obstacle that reduces women’s labor supply is the existing tax, social security and pension policies that have been described as a “male breadwinner” system (Osawa 2004). While the Japanese income tax follows an individual filing regime, the system of exemptions for dependent spouses essentially make the couple the tax unit and penalizes the secondary earner (Osawa 2004). The tax, social security and pension policies create a disincentive for women to join the labor force, and these are discussed in turn.

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13. By law, the part-time workers are defined as those that work less than regular workers in their work place, but in practice, the definitions vary according to the government surveys used (National Women’s Education Center 2003). Part-time workers in figure 1.9 are defined according to the Labour Force Survey (Statistics Bureau 2004) as those who are designated as part-time workers in their work place.

Firstly, for a married couple, if the secondary earner is a part-time worker and earns less than ¥1,030,000 a year, the secondary earner benefits from a full tax exemption and pays no tax (Ministry of Finance 2009).[14]

Secondly, the Allowance for Spouses in the income tax system gives a fixed amount of deduction (¥380,000) to the primary earner if the secondary earner makes less than ¥1,030,000 a year (Ministry of Finance 2009). For every yen that the secondary earner makes between ¥1,030,000 and ¥1,410,000 a year, the deduction given to the primary earner falls by one yen under the Special Allowance for Spouses (Ministry of Finance 2009).

Thirdly, the secondary earner can participate in the public health insurance system (Employees Health Insurance for employees or National Health Insurance for self-employed or unemployed) without paying medical insurance premiums if the secondary earner makes less than ¥1,030,000 a year and his/her annual income is less than half the income of the primary earner (Social Insurance Agency 2009).[15] However, an individual has to pay medical insurance premiums if he/she is a part-time worker and works more than ¾ of the regular workers' hours at his/her own work place (Social Insurance Agency 2009).

Fourthly, the public pension system also creates a disincentive for women to join the labor force. The Basic Pension is paid to the elderly (age 65 and above) who have paid premium payments for at least 25 years (National Institute of Population and Social Security Research 2007). A secondary earner can be a dependent spouse of an eligible person and receive pension benefits without paying premiums, but the dependent spouse must not earn more than ¥1,300,000 a year (equivalent to approximately 14,441 dollars in 2009 exchange rate) (Osawa 2004). Once the secondary earner makes more than the ceiling, they have to start paying premiums.

The system of tax exemptions, public health insurance and pension eligibility for a dependent spouse is complicated and creates a large disincentive for women to work long hours and increase their

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14. Part-timer workers are defined as those that work less than the regular workers in their work place (Ministry of Health, Labour and Welfare, Japanese Government 2006c).

15. All residents of Japan are required to participate in the public health insurance system (Social Insurance Agency 2009). The current medical insurance premium rate is 8.2 percent of monthly income from salary, allowances and bonuses, and the monthly income is categorized into 47 groupings with the highest monthly income fixed at ¥1,210,000 (Social Insurance Agency 2009).

income in order to stay below the respective eligibility ceilings (Osawa 2004). 20.4 percent of part-time workers adjust their working hours and earnings to stay below the eligibility ceilings for tax and pension purposes (Ministry of Health, Labour and Welfare 2006c). 44.1 percent and 67.1 of women who adjust their working hours do so because they do not want to surpass the ¥1,300,000 a year ceiling for the dependent spouse pension ceiling and the ¥1,030,000 a year income tax exemption limit, respectively (Ministry of Health, Labour and Welfare 2006c). Hence it is clear that current tax and pension policies create a large disincentive for women to participate and work longer hours in the work force. Akabayashi (2006) estimates that women's hours of work would increase by 2.9 percent if the government abolished the Allowance for Spouses and Special Allowance Spouses in the income tax and the exemption for premium payments for dependent spouses in the Basic Pension.

In contrast, men's labor force participation rate is consistently high at approximately 95 percent between the age of 30 and 54 in 1995 in figure 2.10. This has fallen by a few percentage points in 2005, but still high at 92.1- 93.8 percent for the same age interval.

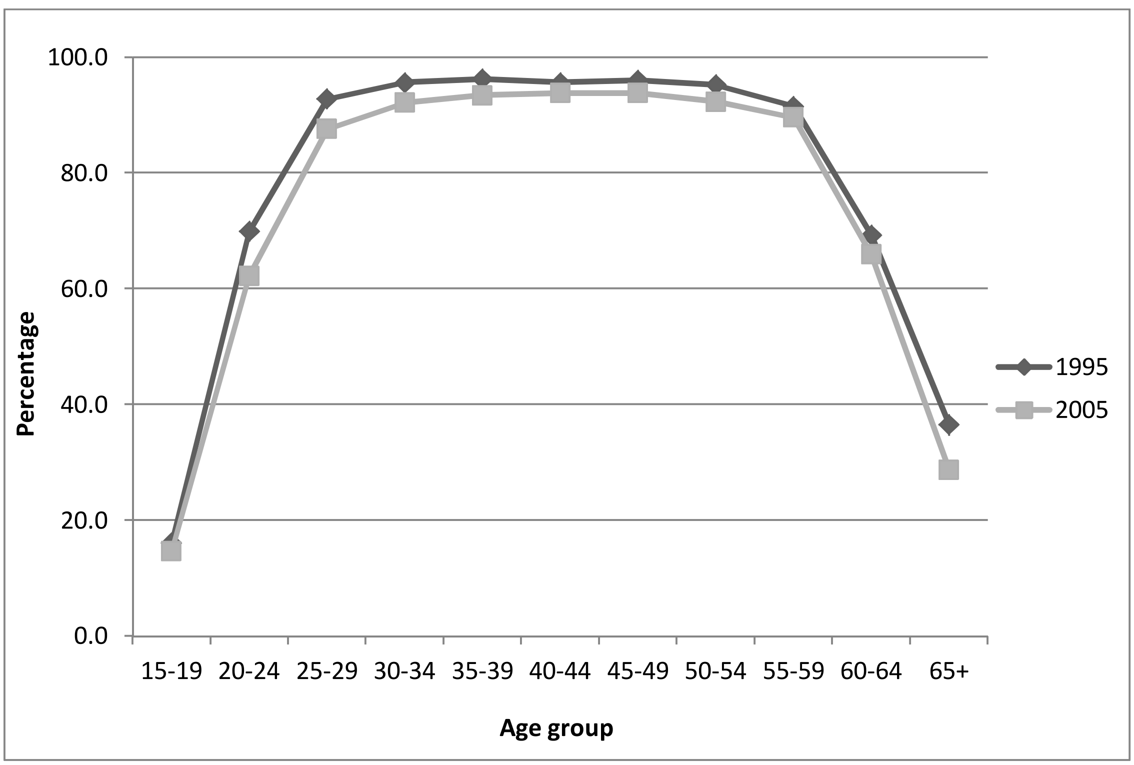


Figure 2.10. Men's Labor Force Participation Rate by Age in 1995 and 2005. *Note:* Adapted from the Statistics Bureau (2009).

The National Institute of Population and Social Security Research (2005) examines whether the women's work status a year after the first child is born has an effect on the average number of children they eventually have. The statistics show that there is actually little difference in the number of children, particularly among couples who have been married for a longer duration. This is shown in figure 2.11.

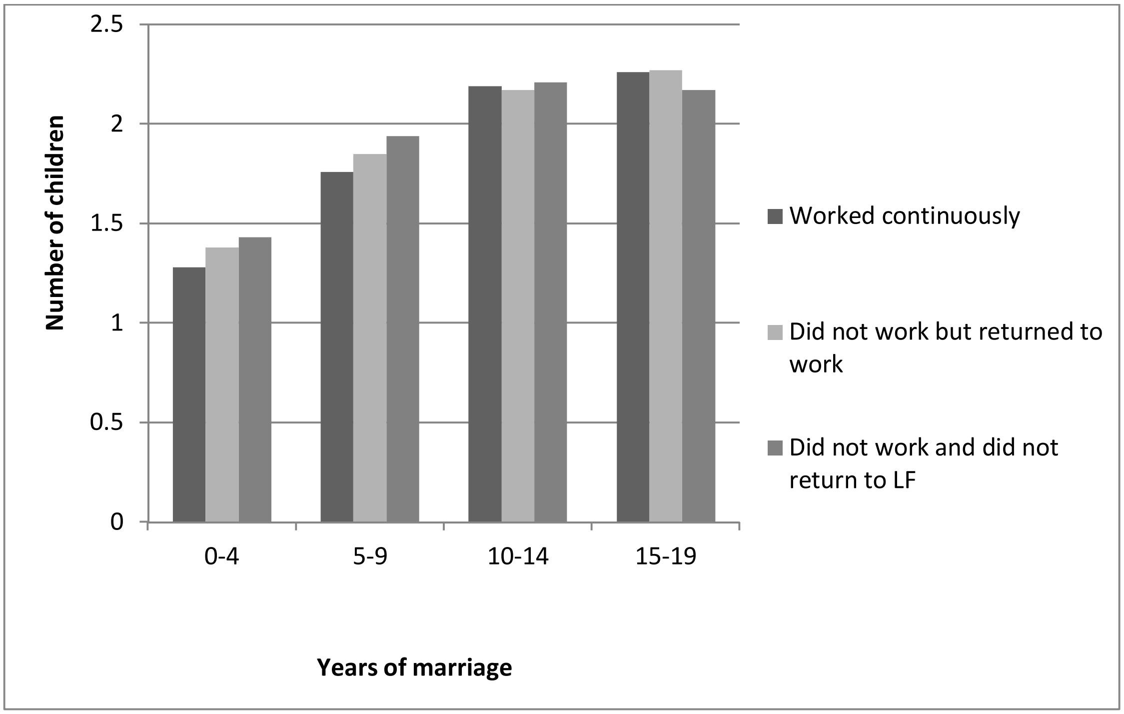


Figure 2.11. Average Number of Children by Wife's Workforce Status. *Note:* Adapted from National Institute of Population and Social Security Research (2005). Women Who "Worked Continuously" Are Those Who Worked One Year after the First Child Is Born and Continuously Worked. Women Who "Did Not Work but Returned to Work" Are Those Who Did Not Work One Year after the First Child Is Born but Returned To Work. Women Who "Did Not Work and Did Not Return to LF" Are Those Who Did Not Work One Year after the First Child Is Born and Did Not Return to the Labor Force.

Among couples whose marriage duration is less than 5 years, women who were housewives one year after her first child was born and did not return to the labor force have slightly more children (1.43 children) compared to women who worked one year after her first childbearing and continue to remain in the labor force (1.28 children). However, among couples whose marriage duration is between 15 to 19 years, women who worked one year after her first child is born and continue to work has more children on average (2.26 children) than women who was a fulltime housewife and remain to be so (2.17 children). While the difference is small, the inability to balance work and family may have prevented women from having more children. This suggests again that the question of who takes care of the children becomes an important consideration.

2.5 Regional Differences in Fertility

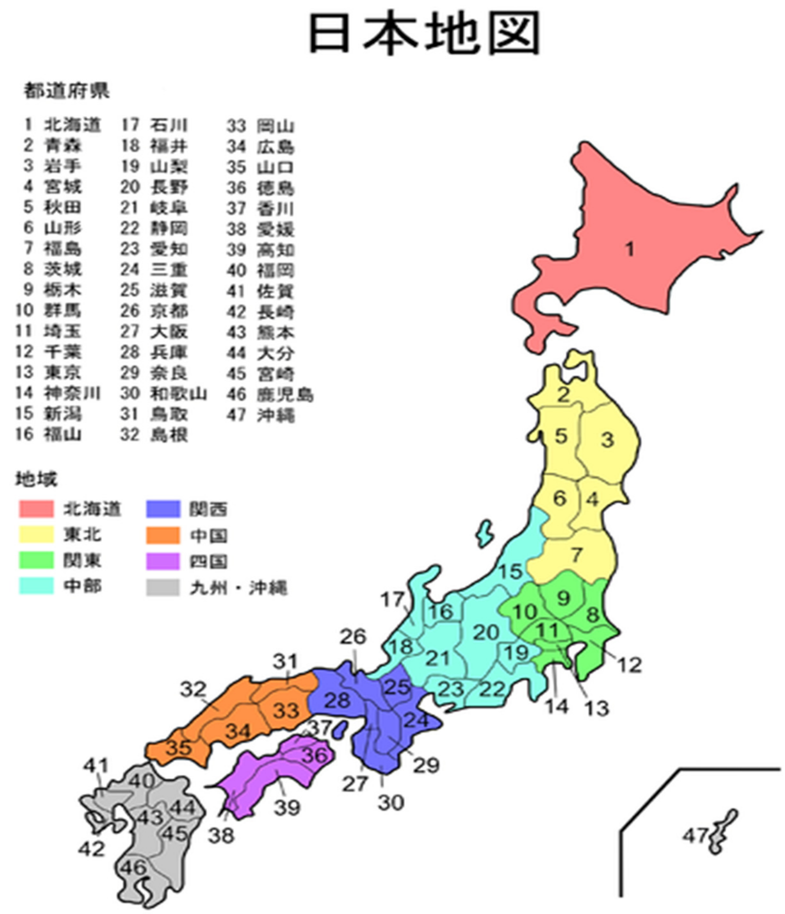
Considerable regional differences in fertility rates exist across Japan as shown in Table 2.1. The Metropolitan Tokyo and Osaka and their suburbs have a lower fertility rates than other regions (with the exception of Hokkaido, whose rate is similar to Tokyo). For example, Tokyo's fertility rate stands at 1.09 compared to the southern island of Okinawa that has the highest fertility rate of 1.78. Okinawa has a unique history and culture because it was independent from Japan as a kingdom and as a U.S. occupied territory (Kerr 2000). The difference in fertility rates could reflect the difference in the culture and customs. Generally, the fertility rates of prefectures in the south islands of Kyushu are higher than 1.53 and for the central regions of Toukai, Chubu and Kitakanto, the fertility rates are over 1.4. (Figure 2.12 provides the map of Japan).

In summary, we find that over time, women are getting married later in life and delaying child bearing. The proportion of women and men in their reproductive ages who are getting married is declining and married women are having fewer children. Women are unable to balance work and childcare and it is particularly difficult for more educated women. These factors contribute to the declining fertility. However, the woman's work force status after her first child is born does not affect the number of children she eventually has.

2.6 Government Responses to Declining Fertility Rates

The government's response to declining fertility has gradually expanded from efforts to support working mothers (through provision of daycare services) to direct public support for families with children.

In the last decade, the government has developed five-year Angel Plans in 1994 and 1999 in an attempt to address the declining population (National Institute of Population and Social Security Research, 2003b). The Plans have focused on helping working mothers in childcare by promoting the development of day care centers and increasing the diversity of available services. A policy of "Zero Waiting List for Daycare Program" was approved in 2001, but as of 2005, 23,338 children are on a waiting list, 67.8 percent



Legend

Regions	Prefectures
Hokkaido	1. Hokkaido
Touhoku	2.Aomori 3. Iwate 4. Miyagi 5. Akita 6. Yamagata 7. Fukushima
Kita-Kanto	8. Ibaragi, 9. Tochigi, 10. Gunma
Metropolitan Tokyo	11. Saitama, 12. Chiba, 13.Tokyo, 14. Kanagawa
Chubu	15 Niigata 16 Toyama 17 Ishikawa 18 Fukui 19 Yamanashi 20 Nagano 21 Gifu 22 Shizuoka, 23 Aichi
Metropolitan Osaka	26.Kyoto 27.Osaka, 28. Hyogo 29. Nara
Tokai	24. Mie 25 Shiga, 30 Wakayama
Chugoku	31 Tottori, 32 Shimane 33 Okayama 34 Hiroshima, 35 Yamaguchi
Shikoku	36 Tokushima, 37 Kagawa, 38 Ehime, 39 Kouchi
Kyushu	40 Fukuoka, 41 Saga, 42 Nagasaki, 43 Kumamoto, 44 Oita, 45 Miyazaki, 46 Kagoshima
Okinawa	47 Okinawa

Figure 2.12. Map of Japan. *Note:* Reproduced From http://commons.wikimedia.org/wiki/File:Japan_map.png.

Table 2.1. Prefecture Level Fertility Rates in 2008

Regions	Number in map	Prefectures	Fertility rates in 2008
Hokkaido	1	Hokkaido	1.2
Touhoku	2	Aomori	1.3
	3	Iwate	1.39
	4	Miyagi	1.29
	5	Akita	1.32
	6	Yamagata	1.44
	7	Fukushima	1.52
Kitakanto	8	Ibaragi	1.37
	9	Tochigi	1.42
	10	Gunma	1.4
Metropolitan Tokyo	11	Saitama	1.28
	12	Chiba	1.29
	13	Tokyo	1.09
	14	Kanagawa	1.27
Chubu	15	Niigata	1.37
	16	Toyama	1.38
	17	Ishikawa	1.41
	18	Fukui	1.54
	19	Yamanashi	1.35
	20	Nagano	1.45
	21	Gifu	1.35
	22	Shizuoka	1.44
	23	Aichi	1.43
Toukai	24	Mie	1.38
	25	Shiga	1.45
	30	Wakayama	1.41
Metropolitan Osaka	26	Kyoto	1.22
	27	Osaka	1.28
	28	Hyougo	1.34
	29	Nara	1.22
Chugoku	31	Tottori	1.43
	32	Shimane	1.51
	33	Okayama	1.43
	34	Hiroshima	1.45
	35	Yamaguchi	1.43
Shikoku	36	Tokushima	1.3
	37	Kagawa	1.47
	38	Ehime	1.4
	39	Kouchi	1.36
Kyushu	40	Fukuoka	1.37
	41	Saga	1.55
	42	Nagasaki	1.5
	43	Kumamoto	1.58
	44	Oita	1.53
	45	Miyazaki	1.6
	46	Kagoshima	1.59
Okinawa	47	Okinawa	1.78

Note: Adapted from the Ministry of Health, Labour and Welfare (2008). For the number in the map, please see figure 2.12.

of whom are under the age of two (Suzuki 2006). If women wanted to continue working after childbirth, the lack of childcare services available especially for smaller children is a continuing problem.

The government has introduced childcare leave in 1991 with several amendments made to incorporate paid leave and make exemptions for social security premiums (Suzuki 2006). Further, the government is encouraging men to participate in childcare by making available the paternity leave law to men in 2009 and creating an initiative called “ikumen project” which literally means men who raise their children (Ministry of Health, Labour and Welfare 2010). Currently, only 1.72 percent of men take paternity leave even though 30 percent of men would like to take paternity leave (Ministry of Health, Labour and Welfare 2010). They set the target of 10 percent of men taking paternity by 2017 and 13 percent by 2020. Details of parental leave were discussed earlier in section 2.4.

Realizing the need to change the working conditions especially for working mothers, the government encourages employers to institute more flexible working hours. In 2003, the government mandated firms with over 300 employees to develop action plans to reconcile work and childcare, and to encourage fathers to be involved in childcare (National Institute of Population and Social Security Research, 2003b). However, the implementation of these companies’ action plans is not legally required (National Institute of Population and Social Security Research, 2003b).

The eligibility for receiving child allowance, available only for low and middle-income families[16], has been gradually increasing from three-year old children to eight year olds (Suzuki 2006). There are tax advantages for having children. There is an income tax exemption of 380,000 yen for a dependent child under 16 years old, and a local tax exemption of 330,000 yen (Suzuki 2006). In addition to these, local governments at city and ward levels provide additional support, either in the form of direct payments or health services according to their local policies (Cabinet Office 2005). The newly elected Democratic Party in August 2009 has stated in its *Manifesto 2009* that reversing the declining fertility as one of its top priorities (Democratic Party 2009). They make the following commitment related to fertility and childcare to: a) increasing the one-time subsidy payment for women who just delivered a child from 42,000 yen

16. This excludes about 15 percent of families in 2003 because they surpass the income eligilibity (Suzuki 2006).

(approx. $464.6) to 55,000 yen (approx. $608.4); b) providing 31,000 yen (approximately $345.0) a year to families with children until the last year of junior high school; and c) subsidizing costs of sending children to senior highs schools, including private school. While these measures are likely to help families with children, it is unclear how successful they will be in reversing the declining fertility rates.

CHAPTER 3

LITERATURE REVIEW ON FERTILITY DECISION MAKING AND INTRAHOUSEHOLD DIVISION OF LABOR

This chapter discusses the literature on fertility decisions and the intra-household division of labor. It seeks to put into context their relevance to and limitations of analyzing fertility in Japan.

Existing economic literature on fertility decisions is driven by an attempt to explain the declining trend in fertility in the face of increasing incomes in developed countries (Becker 1991, Hotz, Klerman and Willis 1997). The analyses focus on the cost of children in the form of: (a) women's opportunity cost of childbearing and childcare and its impact on women's labor supply; and; (b) couples facing a trade-off between the demand for the number of children and the quality of children (i.e. increasing investment per child) as income rises (Becker 1991, Willis 1973). The studies assume that women are the main caretakers of children and their husbands specialize completely in the labor market, playing no role in housework and childcare (Becker 1991, Francesconi 2002, Heckman and Walker 1990, Hotz and Miller 1988, Willis 1973). An increase in women's wages causes an income effect, increasing the demand for children, but this could be offset by a substitution effect because of the opportunity cost of their time in childcare becomes greater, reducing the demand for children. Men's incomes are assumed to have an exogenous effect on fertility decisions creating an income effect, thereby increasing the demand for children if quantity demand for children dominates the quality demand.[17]

This literature on fertility decision-making models can be classified into two strands: one referred to as the static models of fertility and the other as the life cycle models of fertility (Hotz, Klerman and Willis 1997).

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17. Quality of children could be measured by desired human capital investment in, e.g. education per child (Becker and Tomes 1976).

3.1 Static Models of Fertility

The static models of fertility estimate the lifetime completed number of children and analyzes the demand for children in a one period decision-making framework (Becker 1960, Willis 1973). One of the most influential of these is by Willis (1973) who formally introduces childcare time and goods requirements in a fertility model. In Willis' model (1973), the couple maximizes their utility subject to a production possibility function producing child services and the adult's standard of living. This is a general equilibrium framework where the couple maximizes utility subject to a budget constraint, and the couple minimizes their expenditure subject to a production possibility function. These two stages occur simultaneously (Willis 1973).

In the first stage, parents derive utility from the completed number of children (*n*), the quality of children (*q*) and standard of living (*S*). Willis (1973) defines adult standard of living as leisure and consumption, but we simplify this by defining adult standard of living *S* as consumption in this chapter.

$$U(n, q, S) \qquad (3.1)$$

Child services (*C*) need to be produced to take care of children and Willis (1973) defines this to be the product of *n* and *q*. The household budget constraint is:

$$I = \pi_c\, nq + \pi_s S \qquad (3.2)$$

*W*here *I* is full income, π_c is the shadow price of child services and π_s is the price of goods consumed by the couple.

The couple maximizes family utility (3.1) subject to the household budget constraint (3.2). The couple's utility is maximized when the ratio of marginal utility to its marginal cost is equal. This gives the family demand for *n, q* and *S* as a function of full income I, shadow prices π_c and π_s.

$$U_s/\pi_s = U_n/q\pi_c = U_q/n\pi_c \qquad (3.3)$$

Where U_i is the marginal utility of *i* and $i = S, q, n$.

The marginal rate of substitution between *n* and *q* is the ratio of their marginal utilities which is equal to the ratio of *q* and *n* from (3.3):

$$U_n/U_q = q/n \qquad (3.4)$$

A rise in the quantity of children n increases the cost of the quality of children, which further reduces the demand for the quality of children (Hotz *et al* 1997). An increase in income would cause a larger demand in child quality than the number of children if the income elasticity of demand for child quality is larger than that of the quantity of children (Hotz *et al* 1997). This is known as the quantity-quality trade-off and has been used to explain why fertility rates have been declining in the face of rising incomes in developed countries (Becker 1991, Hotz *et al* 1997).

In the second stage, the couple minimizes input costs subject to a production possibility frontier. The husband and wife purchase goods from the market and allocate the wife's labor to produce child services (*C)*, which is the product of number of children (n) and child quality (q), and the parents' standard of living *(S)*. C is the provision of childcare including the mother's time and market goods needed for childcare, while S could be considered to be the provision of housework (such as cleaning and cooking). The production functions of C and S exhibit constant returns to scale and are given below:

$$C = nq = C(t_c, x_c)$$

$$S = S(t_s, x_s) \qquad (3.5)$$

Where x_c is the goods required to provide child services and x_s is the goods required for consumption. The husband is assumed to provide no childcare or housework, so his time is fully spent in paid work earning an exogenous income (Y). Thus, the wife's has to allocate her time between the labor market (h) and in producing C and S (denoted as t_c and t_s, respectively):

$$T = h + t_c + t_s \qquad (3.6)$$

Where T is the total time the wife has available net of basic sustenance such as sleeping and eating. The couple is assumed to pool their respective income, hence the household budget constraint is given by:

$$Y + wh = p(x_s + x_c) \qquad (3.7)$$

Where w is the wife's wage rate and p is the vector of prices for market goods.

The couple minimizes expenditure (3.7) subject to the production functions (3.5) and the wife's time constraint (3.6). Cost minimization occurs when the marginal rate of technical substitution, which is the ratio of the marginal products, is equal to the ratio of input costs as shown below.

$$S_{ts}/S_{xs} = C_{tc}/C_{xc} = W/P \qquad (3.8)$$

Where S_i and C_i are the marginal products of input i, and $i = t_s, x_s, t_c, x_c$.

The ratio of the marginal products in equation (3.8) also measures the wife's shadow wage. A woman enters the labor market when her market wage rate is greater than her shadow wage and allocates her time between paid work, child services (*C*) and adult standard of living (*S*) until equilibrium in (3.8) is restored.

An increase in the wife's wage rate could reduce the production of child services (*C*) due to the substitution effect, but it could also increase the production of C from an income effect. Hence, the overall effect on C is unclear (Hotz *et al* 1997). Further, the effect of an increase in the wife's wage on the quantity and the quality of children, through rising incomes, depends on the income elasticity of demand for quantity versus that for quality (Hotz *et al* 1997). For example, if an increase in the wife's wage causes a greater production of C (which is a product of *q* and *n*) through an income effect, then it could increase the demand for child quality over quantity if the income elasticity of demand for quality is greater than that for quantity (Hotz *et al* 1997).

These models were developed in order to explain the relationship between the tradeoff between women's wages and fertility. They focus on the completed number of children and do not analyze the fertility decision responses, including inter-birth spacing, to changes in prices and incomes (Hotz and Miller 1988).

3.2 Life Cycle Models of Fertility

Life cycle models examine fertility in a dynamic decision-making setting, and changes in prices and incomes over one's lifetime have an impact on the timing and spacing of births (Hotz and Miller 1988, Hotz *et al* 1997, Moffitt 1984, Newman and McCulloch 1984). Changes in wages, incomes and childcare costs explicitly affect inter-birth spacing. For example, Heckman and Walker (1990), using Swedish data, find that the higher the female wages, the longer the inter-birth spacing, and the lower the total number of births. Most studies model opportunity cost of women's time to be measured by her wage rate. An exception to this is by Hotz and Miller's (1988) who incorporate women's unpaid work, namely childcare time, in a lifecycle model fertility model. The cost of childcare includes the mother's time devoted to childcare, and is a declining function of the age of existing children. They make use of information on women's time spent on childcare available for one year in the U.S. Panel of Income Dynamics longitudinal data. They find that the time cost of childcare of the wife reduces the birth probability. No other study has used time use on unpaid work in a fertility study.

Hotz *et al* (1997) and Hotz and Miller (1988) analyze the demand for children and women's time allocation between labor supply in a life cycle model setting. They treat the husband's income as exogenous and assume that he does not perform any housework. Therefore, only the wife has to determine how to allocate her time between paid and unpaid work and the husband spends all his time in the labor market.

As an example of the life cycle model of fertility, we discuss the Hotz and Miller's (1985) model. Note that these models typically do not consider the quality of children hence only the number of children is analyzed. The household maximizes the following expected lifetime household utility function.

$$U \ = \ \sum_{t\,=\,0}^{T} \beta^t u(n_t + b_t, S_t) \quad (3.9)$$

Where $ß^t$ is the household's time preference rate, n_t is the number of children the couple has at time t, $b_t = 1$ if a child is born at time t and zero otherwise. S_t is the provision of home production at t. $t = 0$ is the date of marriage and T is when they die. The number of children at time t is a sum of the children born in the past:

$$n_t \ = \ \sum_{t\,=\,0}^{t-1} b_t \quad (3.10)$$

Hotz and Miller (1986, 1988) assume that the husband provides no help in housework, so his time is fully spent in the labor market where he obtains exogenous earnings of Y_t. The proportion of time the wife has available net of maintaining herself is divided between childcare (C_t), home production (h_t) and market work (m_t). This is expressed as:

$$1 = C_t + h_t + m_t \quad (3.11)$$

The proportion of time the wife spends in childcare (C_t) is determined by the age of existing children (Hotz and Miller 1988).

$$C_t \ = \ \sum_{r\,=\,1}^{t} \delta^{r-1}\, b_{t-r} \quad (3.12)$$

Where δ is a positive constant determined by the available childcare technology and $0 < \delta < 1$. Equation (3.12) shows that the older the children, the less time the wife needs to spend in childcare.

Home production S_t is produced by the wife's work in housework (h_t) and market goods (x_t) (Hotz and Miller 1986).[18]

$$S_t = S_t(h_t, x_t) \qquad (3.13)$$

The budget constraint the couple faces at *t*, without the possibility of saving and borrowing, is (Hotz and Miller 1986):

$$Y_t + m_t w_t \; = \; x_t + \alpha n_t \qquad (3.14)$$

Where w_t is the wife's wage rate at *t* which exogenous and αn_t is the cost to take care of children which is proportional to the number of children. For simplicity, we assume that the price vector for purchased goods is normalized to one.

Today's decisions on consumption, the wife's time spent in home production, childcare and market work have an impact on future levels of utility. A value function $V(Y_t, n_t, S_t)$ is defined as the maximal value of present value of utility at time *t* as a function of the state variables Y_t, n_t, S_t shown below.

$$V(Y_t\ , n_t, S_t) = \; maxE_t \sum_{t=0}^{T} \beta^t u(n_t, S_t) \qquad (3.15)$$

Substituting the time constraint (3.11) and budget constraint (3.14) into the household production function and substituting this production function (3.13) into (3.15) gives:

$$V(Y_t, n_t, S_t) \; = \; max_m \, E_t \sum_{t=0}^{T} \beta^t u[\, n_t, S_t(1 - C_t - m_t, Y_t + m_t w_t - \alpha n_t)] \qquad (3.16)$$

The maximal value of $V(Y_t, n_t, S_t)$ is consistent with the maximal value of home production S_t which is obtained by choosing optimal levels of the wife's labor supply (Hotz and Miller 1986). The wife's shadow wage is equal to the marginal rate of substitution between her time in household production and market goods for household production. Her labor supply is given at a point where her shadow wage rate is equal to the exogenous market wage rate. When the child is younger, more maternal time is required for childcare, and therefore her shadow wage rate is higher. In this case, she is likely to withdraw from the labor market if her shadow wage rate becomes greater than the market wage. With regards to fertility decision at time *t*, a couple decides to have a child at *t* (i.e. b_t=1) if the present value of utility by having a child is greater than the present value of utility of not having a child show below (Hotz and Miller 1986).

$$U(n_t+1, S_t)+\beta V(Y_{t+1}\ , n_{t+1}, S_{t+1}, C_{t+1} \mid b_t = 1) > U(n_t, S_t)+\beta V(Y_{t+1}\ , n_{t+1}, S_{t+1}, C_{t+1} \mid b_t = 0) \qquad (3.17)$$

18. Hotz and Miller (1986) include an uncertainty term in the home production equation, but we exclude this term for simplicity.

Hotz and Miller (1986) show that if $V(Y_t , n_t, S_t)$ exhibits diminishing returns in n_t and C_t, the couple is more likely to use contraception because the additional utility gained in having another child is likely to be lower. When the existing child is younger, the maternal childcare time C_t required is higher from the childcare equation 3.12. This is likely to cause the couple to space births until the youngest child is older and hence C_t is lower. Note that this model does not assume that economies of scale can be achieved by shortening the birth intervals. Newman and McCulloch (1984) argue that possible economies of scale gain in having children at close intervals could shorten birth intervals. Since childcare is time-intensive, women could shorten the overall time of being out of the labor force by having children at short intervals. Further, some market goods could be used for both children simultaneously.

When there is no capital market (i.e. households are unable to save and borrow such as the case above), a rise in the husband's earning profile is likely to increase birth spacing (Hotz *et al* 1997). This is because couples are expected to delay childbearing until they have higher income, in order to smooth consumption because having children entails costs. On a study of Sweden, Heckman and Walker (1990) find that a higher husband's income is associated with shorter birth intervals and more children, although the effect becomes weaker when marital status is controlled for. Similarly, Hotz and Miller (1988) find that the higher the husband's income, the higher the birth probability in the U.S.

With perfect capital markets, Hotz (1979) shows that exogenous changes in the wife's wages on fertility depend on the growth rates of wages relative to the interest rates. If wages rise faster than the interest rate, then the couple is likely to space childbearing, and the reverse is predicted if the interest rate rises higher than the increase in the wage rate. This is because if her wage rises faster, it is better for her to delay childbearing and reduce the time being out of the labor force. On the other hand, Newman and McCulloch (1984) proposes that a rise in female wages could reduce birth spacing if there are economies of scale because it is more cost effective in terms of childcare time required and purchased goods to have children at a shorter interval and minimize the time being spent out of the labor force. Heckman and Walker (1990) find that a rise in female wages has a negative effect on the completed number of births and lengthens the inter-birth spacing in Sweden. Hence, the former reasoning seems to dominate the economies of scale argument in this case.

The above discussion indicates the opportunity cost of having children arises from the mother's income lost for not working in the labor market because the bulk of childcare falls on her. This has an effect on spacing and birth probabilities. The husband's contribution in existing literature appears only in the form of income earned since he does not provide any housework or childcare.

3.3 Relevance of the Fertility Literature

The existing literature on fertility provides a useful framework and tools for analyzing fertility by maximizing behavior in the context of budget and time constraints and changing prices. However, there are two limitations of the static model and life cycle models on fertility in studying declining fertility in Japan. Firstly, the models assume that the wife bears completely the childcare responsibilities with no contribution from the husband. However, there is evidence in Japanese surveys suggesting that women are reluctant to have more children if they husbands are unhelpful in house chores and taking care of their children (Ehara 2004, Meguro 2004, National Institute of Population and Social Security Research 2003a, National Institute of Population and Social Security Research 2005). Women's resistance towards gender-assigned household responsibilities can reveal itself in their unwillingness to having multiple children, but the current literature cannot analyze this issue. This leads to the second point, namely that the literature assumes that individual preferences can be summarized into a single family utility function. This implicitly suggests that the number of children the wife and husband want to have is the same. This approach has been criticized by Folbre (1983) who argues that the literature: a) ignores the possibility that economic, or social gender inequalities could be one of the explanations of declining fertility in developed countries; and b) does not pays attention to the presence of conflicts and bargaining in a family's decision making.

As Folbre (1983) mentions, there is a paucity of fertility decision-making models that incorporate intra-household bargaining. The only one to date is by Iyigun and Walsh (2007) who develop a two-stage bargaining model of fertility. In the first stage before marriage, each spouse determines the level of investment they make in education, and in the second stage, the couple determines how many children they would have. The model predicts that each spouse overinvests in education than the optimal amount in order to increase their bargaining power in marriage. However, the model incorporates most of the assumptions of existing fertility literature by assuming that the wife is the only childcare provider while the husband specializes in market work, and by summarizing the couple's desired number of children by a single household utility function. The model does not distinguish the differences in the demand for children between the spouses.

In recent years, an increasing attention has been given to the effect of gender inequality on fertility rates by several scholars in research institutions in Japan (Ehara 2004, Meguro 2004, National Institute of Population and Social Security Research 2003a, National Institute of Population and Social Security Research 2005). National surveys show that women who gave a higher rating on their husband's performance in childcare were more likely to plan to have more children (National Institute of Population and Social Security Research 2003a, National Institute of Population and Social Security Research 2005). However, most fertility studies and surveys analyzing the husband's unpaid work on fertility decisions in Japan so far do not use a multivariate analysis. It is an estimate of the correlation between the wife's rating of her husband's performance in childcare and fertility plans for more children. Therefore, they are not able to isolate the effect of the husband's unpaid work from other factors such as education and income that could affect unpaid work.

The only study using a multivariate analysis to date in Japan is by Koba, Yasuoka and Urakawa (2009) which find that the number of housework and childcare activities the husband carries out has a positive correlation with the husband and wife's level of desire to have another child (the husband and wife estimated separately), controlling for other factors. The dependent variable, namely the desire to have another child, is classified into five levels, starting from "absolutely do not want another child" to "absolutely want another child" (Koba, Yasuoka and Urakawa 2009). The result using only the husband's sub-sample could be interpreted as the husband contributing to housework because he wants more children. However, their study uses cross-section data and analyzes the woman's desire to have another child, and not whether a child was born. In fact, none of the above-mentioned studies investigate the effect of the husband's role in unpaid work on whether a birth was actually observed. Koba, Yasuoka and Urakawa (2009) argue that the woman's desire to have another child is likely to lead to the birth of another child. Hence, a more direct way to predict the husband's unpaid work on fertility is preferable than on a measure of the woman's desire to have a child, since the latter is subjective and could vary from woman to woman. Further, they do not distinguish the birth probability of the birth order of the child. Factors affecting each birth order may be different and is more appropriate in a developed country context since considerations determining having the first child may be different from those determining having the second child (Hotz *et al* 1997).

3.4. Literature on Intrahousehold Division of Labor of Unpaid Work

A brief literature review on intra-household division of labor in housework is discussed in this section. This literature can be broadly classified into four areas: (1) unitary model; (2) collective household models; (3) cooperative bargaining models; and (4) separate sphere's bargaining model.

3.4.1 Unitary Model of the Household and Intra-household Division of Labor

Becker (1976) is undoubtedly the pioneer in providing the tools and framework for analyzing household behavior. His work in maximizing behavior under time and budget constraints has provided the economic approach on which other economists have critiqued and/or built on (Pollack 2003). Pollack (2003) goes further to argue that those who study the family in the context of maximizing behavior and equilibrium are followers of Becker as the differences arise mostly in setting the assumptions. Regardless of whether we are followers or criticizers of Becker, it is clear that the Becker's conclusions arise from his strong assumptions (Pollack 2003). One example of this is discussed below.

In his model of the household, Becker (1991) assumes that women have a comparative advantage in home production because women are assumed to possess better innate productivity in housework and men have a comparative advantage in market work because men are born more productive than women. This assumption is a crucial and controversial assumption in determining the household division of labor as will be shown shortly. Efficiency gains are made by each spouse completely specializing in the activity in which he/she has a comparative advantage. The main features of his model (1991) are discussed below.

A couple spends time in housework (t^w by wife and t^h by husband) and purchase goods from the market (x) to produce a good Z that is called home production. This Z-good could be to clean the house or to cook a meal (Becker 1991).The couple maximizes the following home production function (Becker 1991):

$$Z(x, t^e) \qquad (3.18)$$

Where x is the goods needed to produce home production and t^e is the effective time to produce Z.

Each spouse allocates time to produce housework and the effective total time spent in home production is shown as:

$$t^e = \beta t^w + t^h \qquad (3.19)$$

Where t^w and t^h is the time spent in housework by the wife and husband, respectively. β is a constant and $\beta > 1$ because Becker (1991) assumes that the wife is more productive in home production since she possesses an innate ability than her husband due to her biological attributes relating to childbearing. The equation (3.19) implies that the wife and husband's inputs are perfect substitutes scaled by a constant β.

The wife and husband's time constraints are given by:

$$\text{Wife: } T^w = t^w + l^w \qquad (3.20)$$

$$\text{Husband: } T^h = t^h + l^h \qquad (3.21)$$

Where T^w and T^h is the total time available to the wife and husband, net of maintaining themselves and l^w and l^h is the amount of time the wife and husband spends in paid work, respectively.

Becker (1991) assumes that the wife is likely to be less productive in market work than her husband, and that the market wage rate is equal to the person's marginal product in market work. Hence, the wife's wage rate can be shown as:

$$\text{Wife's wage rate} = \alpha\, w_h \qquad (3.22)$$

Where w_h is the husband's market wage which is exogenous, and $\alpha < 1$. The equation shows that the wife's wage rate is a fraction of her husband's wage rate because her productivity in market work is equivalent to only a fraction of the husband's productivity.

The household budget constraint is the sum of the income received by the wife and husband:

$$px = \alpha w_h l^w + w_h l^h \qquad (3.23)$$

Where p is the exogenous price vector of x.

Rearranging (3.20) and (3.21) and substituting into (3.23) gives:

$$px = \alpha\, w_h(T^w - t^w) + w_h(T^h - t^h) \qquad (3.24)$$

Substitute (3.19) and (3.24) into the household production function (3.18) gives:

$$Z\left(\frac{\alpha w_h(T^w - t^w)}{p} + \frac{w_h(T^h - t^h)}{p}, \beta t^w + t^h\right) \quad (3.25)$$

Where $\alpha<\beta$ since $\alpha < 1$ and $\beta > 1$ by assumption.

Differentiating the production function (3.25) with respect to the husband's time in housework t^h, and setting it equal to zero for maximization and rearranging it gives:

$$\frac{w_h}{p}\frac{\partial Z}{\partial x} = \frac{\partial Z}{\partial t^h} \quad (3.26)$$

Equation (3.26) shows that the husband allocates time between housework and market work until his marginal product of home production (on the right hand side of 3.26) is equal to the real opportunity cost of home production (on the left hand side of 3.26).

Maximizing the production function (3.25) with respect to the wife's time in housework t^w and setting it equal to zero gives:

$$\frac{w_h}{p}\frac{\partial Z}{\partial x}\alpha = \frac{\partial Z}{\partial t^w}\beta \quad (3.27)$$

The wife's marginal product of home production (on the right hand side of 3.27) is greater than the husband's marginal product of home production in (3.26) because $\beta > 1$, and her opportunity cost of home production (on the left hand side of 3.27) is less than the husband's opportunity cost since $\alpha < 1$. From equation (3.19), since their housework labor inputs are perfect substitutes scaled by a constant β, maximizing home production requires that the cheaper source of labor specialize in producing that good, namely the *Z*-good (Nicholson 2005). Hence, since the wife has the lower opportunity cost, this implies that the wife should specialize completely in housework and the husband should specialize in market work. This outcome holds even if the home production function exhibits diminishing returns to scale, constant returns to scale or increasing returns to scale (Becker 1991). Therefore the Becker model (1991) implies that in an efficient household, the wife specializes completely in housework and the husband specializes completely in market work because she possess an innate ability in housework, while the husband possesses an innate ability in market work.[19] Becker (1991) assumes that the intra-household allocation of

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19. Gronau (1976) shows that if the husband and wife's labor inputs are not perfect substitutes perfect substitutes in home production, and their inputs exhibit diminishing returns to scale as below:

$$Z(x, t_w, t_h)$$

resources is then determined by the altruistic dictator, namely the husband, who efficiently allocates resources within the household.

Becker's assumption that women and men possess different innate abilities in housework and market work has been criticized by many economists (Bergmann 1995, Beneria 2003). He attributes sex differences which are the biological differences between women and men with gender differences which are the relationships between women and men determined by social norms, culture and institutions. As discussed in Chapter 2, studies in Japan suggest that gender norms are likely to affect division of labor. 44.8 percent of men and 39.8 percent of women believe that a wife should be a full-time home maker and the husband should work outside the home in Japan, and these figures are larger than other developed countries such as Sweden (Cabinet Office 2007). A higher percentage of older generation in their 40s and 50s agrees with this statement than those in their 20s and 30s (Cabinet Office 2007). There is evidence that social norms, culture and institutions play a major role in intra-household division of labor rather than the innate ability driven by whether you are born a man or a woman.

Several economists have pointed out one of the model's limitation that assume that the individual preferences can be summarized into a household utility function since it ignores the power dynamics and conflicting interests within the household in allocating resources and labor (Beneria 2003, Katz 1997). This point has been addressed in later household bargaining models which are discussed below.

3.4.2 Household Collective Models

One approach to incorporate differences in individual preferences is offered by the Household Collective models such as those by Chiappori (1988, 1997). He shows how intra-household labor and resources are allocated by a given income sharing rule. One does not need to know how the income sharing rule came to be, or what kind of bargaining took place to arrive at the sharing rule (Pollack 2003). The only assumption that needs to be made is that the income sharing rule be Pareto efficient (Chiappori 1988, 1997), implying that households bargaining process will lead to efficient outcomes. Individuals maximize one's utility subject to the income constraints given by this sharing rule. Lundberg and Pollack (2003) criticize

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Where $Z''_{tw}<0$ and $Z''_{th}<0$, then each spouse would provide housework until the marginal product of housework is equal to the opportunity cost.

the assumption that household decisions are efficient is implausible, especially when bargaining occurs in a dynamic setting and decisions cannot be binding in future periods. Another restriction the model imposes is that they assume that an efficient sharing rule in expenditure patterns exists, but they do not explain how the sharing rule came to exist (Pollack 2003).

3.4.3 Cooperative Bargaining Models

Another type of approach to incorporate individual preferences is developed by Manser and Brown (1980) and McElroy and Horney (1981) in the Cooperative Bargaining Models. They assume that individuals have their own preferences that cannot be summarized in a household utility function. But they maintain Becker's (1991) assumption that the household pools their income. These models are characterized by allowing gains to cooperation but the allocation of gains depends on each person's bargaining power. Specifically, the allocation of consumption and leisure is determined by the spouses' bargaining power which is affected by their threat points. The threat points are the utilities they can receive outside of marriage, known as reservation utility, and these are determined by their non-labor income, wages and policies related to child support or alimony in case of divorce.

Manser and Brown (1980) show that the bargaining problem can be solved by maximizing the following Nash function:

$$\mathit{Max}\ \mathrm{N} = [U^w(z, x^w, l^w) - T^w(p, w^w, w^h, I^w, I^h)][U^h(z, x^h, l^h) - T^h(p, w^w, w^h, I^w, I^h)] \qquad (3.28)$$

Where $U^i(z, x^i, l^i)$ is the utility of person i and T^i is the threat point of person i, given $i = w, h$.
Each person derives utility from consuming home production which is a public good (z), private consumption (x^i) and leisure (l^i). The threat point (T^i) is a function of p which is the price vector of z, x^w and x^h, the wage rate of person i (w^i), and the income received by person i (I^i) where $i = w, h$. $[U^i(z, x^i, l^i) - T^i(p, w^w, w^h, I^w, I^h)]$ is the gains to cooperation by person i.

The Nash function (3.28) is maximized subject to the following utility and pooled income constraint:

$$U^w(z, x^w, l^w) - T^w(p, w^w, w^h, I^w, I^h) \geq 0$$

$$U^h(z, x^h, l^h) - T^h(p, w^w, w^h, I^w, I^h) \geq 0$$

$$p(z + x^w + x^h) + w^w l^w + w^h l^h - I^w - I^h \leq 0 \qquad (3.29)$$

Maximizing the Nash function (3.28) subject to the constraints (3.29) yields the demand functions:

$$z = h(w^w, w^h, I^w, I^h)$$

$$x^i = f(w^w, w^h, I^w, I^h)$$

$$l^i = g(w^w, w^h, I^w, I^h) \qquad (3.30)$$

Where $i = w, h$.

Individual *i*'s threat point T^i affects the allocation of consumption and leisure. For example, a rise in their wage rate causes an income and substitution effect, but it also increases their threat point which shifts resources in his/her favor (Katz 1997). These models are also attractive for its ability to empirically test the effect of an exogenous increase in public or private income or resources on the intra household allocation (Katz 1997, Pollack 2003). The models predict that improving a woman's status after a divorce (through e.g. legal reforms) or an exogenous increase in non-labor income would improve the distributional allocation (Katz 1997, Lundberg and Pollack 1993). In contrast, the Becker model predicts that an exogenous increase in the women's non-labor income (e.g., no distributional consequences; Schultz 1990).

Some of the limitations and criticisms of the Cooperative Bargaining models have been raised by Katz (1997) who argues that the Nash solution does not give us any insights about how the threat points are used in the intra-household bargaining process, nor how the institutional context or norms enter into the allocation decision. Hence, the way that decisions are made within a household continues to be a black box (Katz 1997). Moreover, there is no guarantee that an allocation from a bargaining process will be imposed (Katz 1997). Lack of enforcement of the allocation could give rise to monitoring costs or costs related to enforcement that take away resources from productive purposes leading to inefficient use of resources (Bowles 2004).[20] Finally, the cooperative models assume that the Nash equilibria are Pareto efficient, but as Pollack (2005) argues, they do not state the conditions in which they arrive at efficiency.

3.4.4 Noncooperative Bargaining Model

Another set of household models that have evolved is referred to as the non-cooperative bargaining models. One such example is Lundberg and Pollack (1993)'s separate sphere's bargaining

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20. Bowles' critique (2004) refers to bargaining literature in general, but his critique on the literature could apply to the household Cooperative Bargaining models.

model which argues that a threat point at divorce may be implausible or unrealistic if divorce entails high transaction costs. This model has three important distinctions from the cooperative bargaining models. Firstly, in the Lundberg and Pollack model (1993), socially ascribed gender roles and norms determine the intra-household division of labor which they call the non-cooperative equilibrium. The threat point is the utility obtained at the non-cooperative equilibrium, rather than the utility you would receive outside of marriage in the cooperative bargaining models. They argue that a non-cooperative equilibrium is a more credible threat point since divorce is likely to incur high transactions costs. Secondly, unlike the cooperative bargaining models where couples pool their income, in the Lundberg and Pollack model (1993), the couples are assumed to control their own resources. The distribution of resources depends on who controls the resources. Thirdly, while the cooperative bargaining models always assume equilibrium is efficient, an inefficient equilibrium could occur in non-cooperative equilibrium models if the spouses decide not to cooperate (Lundberg and Pollack 1993).

Lundberg and Pollack (1993) assume that socially ascribed roles and responsibilities assign each spouse to provide specific household activities, such as childcare to the wife and fixing the sink to the husband. These social roles determine the division of labor between a husband and a wife, as opposed to Becker’s (1991)’s assumption that differences in women and men’s productivity in home production and market work determine the division of labor. These housework activities are public goods so once produced, one cannot exclude the other from consuming them. Hence, social norms could assign the wife to provide childcare (which we call z^1), while the husband has to mow the lawn, or perform maintenance on the house (which we call z^2). The non-cooperative equilibrium is determined by each spouse maximizing his/her utility subject to his/her individual income constraint taking as given the other person’s contribution of housework. The utility maximization solution yields the non-cooperative equilibrium, which is a Cournot equilibrium. The non-cooperative equilibrium is the threat point of each spouse. While the housework activity the husband and wife each specializes in is given by socially ascribed norms, the level of z^1 the wife performs and the level of z^2 the husband performs are determined by this maximization process. Gains to cooperation can be achieved by maximizing the gains of marriage.[21] Factors affecting the threat point (or non-cooperative equilibrium) such as their wages affect the resource allocation within the household.

Lundberg and Pollack (1993) do not elaborate on how the socially ascribed activities come to exist and this assumption is restrictive in a sense that it does not allow a spouse to take on responsibilities that are in the other spouse's domain. For example, it is possible that the husband could take on some activities that are supposedly within the wife's domain such as bathing the child or changing diapers. However, the division of housework activities is assumed to be mutually exclusive. Further, Katz (1997) points out that the model ignores the role that social pressure or peer pressure could play in determining how much housework each spouse contributes.

In contrast, the Carter and Katz's (1998) conjugal contract model shows that the spouses produce a household production good called a z-good which is a public good. Each spouse maximizes individual utility subject to their own budget constraints and expected contribution of other household members.

The utility maximization of each spouse is given by:

Wife:

Max $U_w (x_w, z)$

Subject to:

$p_w x_w \leq w_w l_w + \Phi$

$z = \psi (h_w + \hat{h}_h)$

$l_w + h_w \leq T$

Husband:

Max $U_m (x_m, z)$

Subject to:

$p x_h \leq w_h l_h - \Phi$

$z = \psi(h_h + \hat{h}_w)$

$l_h + h_h \leq T$

where x_i is the private consumption of spouse i, $U_i (x_i, z)$ is the utility of spouse i where $i = w, h$. p is the vector of prices and w_i is the wage rate of spouse i. Prices and wage rates are assumed to exogenous. Φ is the intra-household transfers from the husband to the wife which they assume to be endogenous. l_i and h_i is the time spent in the labor market and housework, respectively by spouse i. T is the time available net of maintaining themselves (such as sleeping and eating).

The production of the z-good is assumed to exhibit constant returns to scale in labor inputs at a positive constant ψ. The labor inputs of both spouses to produce the z-good, namely h_w and h_h, are assumed

21. This is achieved by maximizing a Nash function (of the Cooperative model in 3.27) and replacing the threat points with the non-cooperative equilibrium points in equations (3.28).

to be perfect substitutes. $\hat{h}_h$ is the amount of housework the wife expects her husband to contribute and $\hat{h}_w$ is the amount of housework the husband expects his wife to contribute.

Re-expressing the utility maximization in a Lagrangian equation for the woman is:

$$L_w = U_w(x_w, \psi(h_w + \hat{h}_h)) + \lambda_w[-p_w x_w + w_w(T - h_w) + \Phi] \qquad (3.31)$$

Solving the first order conditions for the wife gives,

$$\partial U_w / \partial x_w = \lambda_w p_w \qquad (3.32)$$

$$\partial U_w / \partial h_w \psi = \lambda_w w_w \qquad (3.33)$$

$$-p_w x_w + w_w(T - h_w) + \Phi = 0 \qquad (3.34)$$

Utility maximization process yields a reaction function for each spouse and the equilibrium is a Cournot equilibrium and the non-cooperative equilibrium, similar to the Lundberg and Pollack model. As shown in the first order condition (3.33), the amount of housework at the non-cooperative equilibrium is determined by the person's wage rate. Carter and Katz (1998) show how the intra-household transfers Φ can be used by the husband to induce his wife to perform more housework. They argue that patriarchy and the degree of voice within the household determines the level of transfers Φ from the husband to the wife. Hence, while the wage rates determine the level of housework each spouse contributes, transfers act as an incentive for the husband to modify the behavior of his wife.

3.4.5 Social Norms and Women's Time Allocation

Kevane and Wydick (2001) directly incorporate social norms of a particular village in the time allocation decision of women in Burkina Faso. They only consider the women's time allocation decision and assume that men's labor supply is completely inelastic and fixed for each activity. Women spend time in farm work (t_a), market work (t_m) and housework (t_h). Market work refers income generating activities that produce outputs that could be sold in the market such as food and beverage.

$$T = t_a + t_m + t_h \qquad (3.35)$$

Benefits to conforming to the norm and non-pecuniary costs to deviating from the norm are defined as

$$\check{S} - \sum_{j=a,m,h}\left(\frac{1}{2}a_j\left(t_j - t'_j\right)^2\right) \qquad (3.36)$$

Where Š measures the non-pecuniary benefits to conforming to social norms and t'_j is the average time women in the social group spend in activity *j*, where *j* =farm work (*a*), market work (*m*) and housework (*h*).

The positive parameter a_j indicates the severity of the non-pecuniary penalty for deviating from the norm for activity *j* in the social group. This parameter varies by group depending on their norms regarding women's participation in each activity. Equation (3.36) shows that the greater a woman deviates from the average time women spend in a specific activity in her social group, the greater the disutility she feels.

The household maximizes the following welfare function subject to the woman's time constraint (3.35):

$$A(K, t_a) + H(K, t_h) + Pmt_m + \check{S} - \sum_{j\,=\,a,m,h}\left(\frac{1}{2}a_j\left(t_j - t'_j\right)^2\right) \qquad (3.37)$$

Where $A(K, t_a)$ is the production function for the agricultural outputs and *K* is the capital inputs required. $H(K, t_h)$ is the production function for home production. Both $A(K, L_a)$ and $H(K, L_h)$ exhibit diminishing returns to inputs. mt_m is the outputs of market work (or income generating activities) and exhibits constant returns to scale. *P* is the vector of prices of goods produced by the income generating activities.

Maximizing (3.37) with respect to t_a, t_h and t_m produces the following first order conditions (Kevane and Wydick 2001):

$$A_{ta} - a_a(t_a - t_a') - \lambda = 0$$

$$H_{th} - a_h(t_h - t_h') - \lambda = 0$$

$$Pm - a_m(t_m - t_m') - \lambda = 0$$

$$T = t_a + t_m + t_h \qquad (3.38)$$

Where λ is the lagrangian multiplier of the time constraint.

From the first order conditions, time allocated to each activity depends on the severity of punishment for deviating from the group norm for that particular activity (a_j) and the level of group norm for an activity (t'_j). Therefore Kevane and Wydick (2001) show different social norms for two distinct tribes in Burkina Faso affect a woman's time allocation decision through the level of punishment she feels about not conforming to the norms of her social group.

3.4.6. Limitations of the Literature on Intrahousehold Division of Labor

Each strand of literature on intra-household division of labor attempts to tackle some of the criticisms of the proceeding literature. For example, collective models, the cooperative and non-cooperative bargaining models recognize the importance of differences in individual desires in determining division of labor in contrast to the Becker model that assume that utilities of household member can be summarized into a household utility function. The introduction of threat points in the cooperative and non-cooperative bargaining models enables the exogenous changes in prices or non-labor income to impact the distributional allocation in the household.

In the Becker model, the Household Collective model and Cooperative Bargaining models, the market wage rates determine the intra-household division of labor and the level of household each spouse provides directly or indirectly through their effects on the threat points. In the Lundberg and Pollack's Separate Sphere's model (1993), the wage rates determine the level of socially ascribed activities each spouse should provide. In the Carter and Katz's Conjugal Contract (1998) model, the wage rates determine each spouse's amount of time allocated housework, but this can be modified according to the socially ascribed intra-household transfers from the husband to the wife. The husband can increase the transfers to induce her to perform more housework. Unlike the literature discussed thus far, Kevane and Wydick (2001) directly examine the role that social norms play in women's time allocation decisions. However, the drawback is that they do not examine men's time allocation decisions since they assume that their labor supply is inelastic.

Therefore, except for Lundberg and Pollack (1993), Carter and Katz's (1998) and Kevane and Wydick (2001), most household models ignore how social norms and institutions can affect the division of labor. Similarly, Akerlof and Kranton (2000) argue that the sense of identity about one's race or sex can affect his or her behavior in a way that is different from the behavior predicted solely by market prices or wages. For example, they argue that if husbands and wives behaved according to their relative share of income they brought to the household, there would have been a more equal division of household work in the U.S. However, the evidence does not support this prediction. Men's labor supply in housework is much more inelastic and they explain that this is because men's sense of identity is lost when they do housework. As discussed before, there is also evidence in Japan that suggest the importance of norms in determining men and women's division of labor in housework. Hence, a new theoretical framework is needed to analyze men and women's time allocation decisions that address social norms.

This chapter reviewed existing literature on fertility decisions and intra-household division of labor of unpaid work. We also highlighted their limitations in analyzing women's fertility decisions and their resistance towards gender assigned household responsibilities. The next chapter develops the theoretical framework in which this problem is addressed.

CHAPTER 4

A STACKELBERG FERTILITY MODEL

4.1 Introduction

The previous chapter highlighted some of the limitations of the existing economic theory on fertility decisions to analyze women's fertility decisions in Japan. The existing economic theory: a) assumes that women bear the full burden of housework and childcare (Becker 1991, Hotz and Miller 1988, Iyigun and Walsh 2007 and Willis 1973); and b) stipulates that preferences on fertility can be summarized into a single household utility function (Becker 1991 and Willis 1973).

The Stackelberg fertility model developed in this chapter differs from the existing literature on fertility decisions in three important ways. Firstly, we propose that fertility decision-making is a reflection of individual desires, preferences and perceptions of social norms and hence individual preferences cannot be seamlessly summarized into a single household welfare function.

Secondly, we incorporate the husband's contribution to housework and childcare as a key determinant in women's decision to have children. Chapter 2 discussed Japanese studies and surveys that highlight women's reluctance to have more children due to the inadequate support received from their husbands in housework (Ehara 2004, Koba, Yasuoka and Urakawa 2009, Meguro 2004, National Institute of Population and Social Security Research 2003a, 2005). These studies indicate that the husbands' support in childcare and housework is indeed an important factor in fertility decisions.

Thirdly, we explore the role that the husband's perception of gender norms and the pressure to conform to these norms play in determining his time allocated to unpaid work. Chapter 1 highlighted how attitudes and norms about gender assigned roles and responsibilities in the intra-household division of labor are prevalent in Japan. 44.8 percent of men and 39.8 percent of women believe that a wife should be a full-time home-maker and the husband should work outside the home (Cabinet Office 2007). Further, 49 percent of respondents of the *Public Opinion on the State of a Gender Equal Society* (men and women in total) believe that men have to change their attitudes and reduce their resistance towards housework in order for them to participate more fully in housework, childcare, elderly care and community work (Cabinet Office 2007).[22] This stands in contrast to only 20.4 of respondents who think that it is the women's attitudes about men's role in housework that have to change for men to participate more fully in these activities (Cabinet Office 2007). This implies that men's attitudes and values towards housework are important determinants of their contribution. We propose that there are two distinct avenues through which attitudes and norms affect the husband's participation in housework, namely the formation of attitudes and values; and the social pressure to conform to these values and norms. The formation of attitudes and values about gender roles is likely to be influenced by the childhood environment, such as the region in which they grew up, because men's interpretation of gender assigned roles and norms on division of labor can vary from region to region. The social pressure to conform to these norms is affected by the social environment in which the husband currently lives, whether in a tight knit community, or an urban setting where neighborhood interaction could be sparse (Fletschner and Carter 2008). These factors, namely the childhood environment and the present social environment, could therefore affect the husband's perception of gender norms and the pressure to conform to these norms. These, in turn, determine the husband's time allocated to housework.

In this chapter, we formulate a Stackelberg fertility model to examine the impact of the husband's time spent in unpaid work on women's fertility decisions.[23] The husband, as the leader, determines how much time to spend in housework based on his perception of social norms and the pressure to conform to them, taking as given his wife's reaction function on her demand for children. The wife, as the follower, determines her demand for children based on his contribution to housework in the first stage. The assumptions of the model are outlined in section 4.2. In sections 4.3 and 4.4, we present the Stackelberg fertility model assuming that the intra-household transfers from the husband to the wife are exogenously given. Section 4.5 summarizes the comparative statics. In sections 4.6, we examine the case when the intra-household transfers are endogenous.

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22. The survey did not disaggregate the results by sex.

23. We use the term unpaid work and housework interchangeably.

4.2 Assumptions of the Model

The basic assumptions of the model are as follows:

1. We restrict the fertility decisions to married couples and we do not consider the decision to form a household.
2. The husband and the wife want children, but ultimately, the wife makes the fertility decision about how many children she wants to have.
3. The household does not pool income, but a fixed amount of intra-household transfers are made from the primary earner (the husband) to the wife and is exogenously given based on prevailing social norms.[24] In order to simplify the model, the husband cannot reduce the time spent in housework by providing more transfers to his wife.
4. There are no economies of scale in the time required to raise children.[25]
5. Raising children does not require market goods in order to simplify the fertility decision and to focus on the parental time required to raise children.

The fertility decision-making can be broadly summarized in the following two stage processes namely:

- Stage 1: Number of children—Husband makes a decision on how much to contribute to housework, taking his wife's reaction function for her demand for children as given.
- Stage 2: Fertility decision—Wife makes decision about how many children to have.

The husband, as the Stackelberg leader, takes as given his wife's reaction function on her demand for children. He can influence his wife's fertility decision by contributing to housework in the first stage. Since children are public goods, once born, both spouses derive enjoyment out of the children. We introduce the notion that his perception of gender norms on intra-household division of labor and the pressure to conform to these norms affects his level of housework following the framework introduced by Fletschner and Carter

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24. This is consistent with the assumption made in Lundberg and Pollack's separate spheres household model (1993). Note that we examine the implications of relaxing this assumption in section 4.6 by making the transfers from the husband to the wife endogenous and set as a fixed proportion of his income.

25. This is consistent with previous literature such as in Hotz and Miller (1988), Iyigun and Walsh (2007) and Willis (1973). Relaxing this assumption may modify the prediction of the model but this is left for future research.

(2008) and Kevane and Wydick (2001). The wife, as the follower, determines how many children she wants to have, taking as given her husband's contribution to housework in the first stage. The optimization results in a Stackelberg equilibrium for the number of children. Therefore the husband's perception of gender norms on the division of labor plays an important role in fertility decisions.

Our model is similar to the Carter and Katz (1992) conjugal contract model where each spouse determines how much housework to perform by maximizing individual utility based on their time and budget constraints. Like Carter and Katz (1992), we assume that spousal contributions to housework are perfect substitutes. However, in the Carter and Katz (1992)'s case, each spouse simultaneously maximizes individual utility based on their individual time and budget constraints, and taking the other spouse's best response function as given. The solution to the maximization process leads to a Cournot non-cooperative equilibrium (before cooperation between the spouses takes place). However, in our model, we introduce a sequential decision making in time allocation between the spouses where the husband is the leader.

In this model, we do not consider the spacing of children and economies of scale that could arise by having children in a shorter duration (Newman and McCulloch 1984). This consideration is left for future research. Because this is a two-stage Stackelberg model, we solve the second stage first to derive the wife's reaction function for her demand for children.

4.3 Stage two: Fertility decision

It is assumed that the wife's utility function in period *t* is a function of private consumption (x_{wt}) and the number of children (n) as below:

$$U^w(x_{wt}, n) \qquad (4.1)$$

Where the marginal utilities of consumption and children are positive, respectively ($U^w{}_x>0$, $U^w{}_n>0$), and marginal utility is diminishing in each argument ($U^w{}_{xx}<0$, $U^w{}_{nn}<0$). We also assume that utility is separable in x_{wt} and n, namely that:

$$U^w{}_{xn} = 0, U^w{}_{nx} = 0 \qquad (4.1)'$$

The total time needed to produce housework and childcare is assumed to be proportional to the number of children *(n)* multiplied by a positive constant ψ.[26]

$$\psi n = C_{wt} + \hat{C}_{ht} \quad (4.2)$$

Where ψn is the total time needed for housework and childcare for n number of children and ψ is a positive constant. The production of the housework and childcare is assumed to exhibit constant returns to scale with a constant term ψ that reflects the available childcare technology affecting childcare time.[27] C_{wt} is the amount of housework and childcare the wife provides and $\hat{C}_{ht}$ is the amount of housework and childcare she expects her husband to provide in period t. The labor inputs of both spouses are assumed to be perfect substitutes. We rule out the possibility of hiring outside labor to look after children or having other household members undertaking childcare.

We assume that the wife forms expectations about her husband's contribution to housework and childcare ($\hat{C}_{ht}$) as a function of his contribution to housework in the previous period at $t\text{-}1$ (Z_{ht-1}). The wife's expectation of her husband's contribution to housework and childcare per child is expressed as φZ_{ht-1} where φ is a positive constant. Z_{ht-1} is predetermined in this period since it took place in the previous period. The more he contributed to housework in $t\text{-}1$, the more she expects him to contribute in t which is scaled by the constant φ. The total housework and childcare time she expects her husband to contribute is φZ_{ht-1} multiplied by the number of children n.

$$\hat{C}_{ht} = n\, \varphi Z_{ht-1} \quad (4.3)$$

Substituting (4.3) into (4.2) and rearranging gives the wife's time requirement for childcare.

$$C_{wt} = (\psi - \varphi Z_{ht-1})\, n \quad (4.4)$$

Where $C_{wt} > 0$. (4.4) shows that the amount of time the wife has to spend in childcare in the second stage is determined by the number of children, her spouse's housework contribution in the first stage and the available childcare technology ψ. The more housework her husband contributed in the first stage, represented by a higher Z_{ht-1}, the less time the wife has to allocate to childcare. The more advanced the time

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26. This is similar to Iyigun and Walsh's (2007) formulation of childcare requirements (though they assume that the wife is the sole childcare provider).

27. For example, introducing a baby monitor could reduce childcare time requirements and this would be reflected by a reduction in ψ.

saving childcare technology is, represented by a lower ψ, the less time the wife has to allocate to childcare too.

The budget constraint the wife faces is the sum of her labor income and the intra-household financial transfer *(Φ)* from the husband to the wife.[28]

$$P_{wt}\, x_{wt} = w_{wt}\, l_{wt} + \Phi \qquad (4.5)$$

Where l_{wt} is the wife's time allocated to paid work, P_{wt} is a vector of prices and w_{wt} is the wife's wage rate, and these are exogenous. We assume that the intra-household financial transfer *(Φ)* is fixed and binding and is determined by social norms.[29] Note that the financial transfer *(Φ)* occurs from the husband to the wife because we are assuming that the husband earns more than the wife, and he gives some sort of housekeeping allowance to this wife.

The total time the wife allocates for paid work (l_{wt}) and housework and childcare (C_{wt}) is at most 24 hours minus time available for self-maintenance (such as sleep, personal care, eating and rest) denoted by T_w.

$$l_{wt} + C_{wt} \leq T_w \qquad (4.6)$$

Substituting the equation for the time the wife's has to spend in childcare (4.4) into her time constraint (4.6) yields:

$$l_{wt} + (\psi - \varphi Z_{ht-1})\, n \leq T_w \qquad (4.7)$$

The wife maximizes her utility (4.1) by choosing levels of consumption (x_{wt}) and the number of children (n) subject to her budget constraint (4.5) and time constraint (4.7) by solving the following Lagrangian equation:

$$L_w = U^w(x_{wt}, n) + \lambda_w [\, - P_{wt}\, x_{wt} + w_{wt}\{T_w - (\psi - \varphi Z_{ht-1})n\} + \Phi] \qquad (4.8)$$

Where λ_w is the lagrangian multiplier on the budget constraint, which is the change in utility due to a change in the budget constraint. Solving the first order conditions for the wife yields the equations

$$U^w_x = \lambda_w\, P_{wt} \qquad (4.9)$$

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28. We assume there is no borrowing or saving for simplicity.

29. Carter and Katz (1992) and Lundberg and Pollack (1993) argue that the intra-household financial transfers could be determined by social norms.

$$U^{w}_{n} = \lambda_{w}\, w_{wt}\, (\,\psi - \varphi Z_{ht-1}\,) \qquad (4.10)$$

$$P_{wt}\, x_{wt} - w_{wt}\, [T_{w}\text{-}(\psi - \varphi Z_{ht-1}\,)n] - \Phi \leq 0 \qquad (4.11)$$

From Kuhn Tucker conditions, $\lambda_w \geq 0$.

Where U^{w}_{x} is the wife's marginal utility of private consumption and U^{w}_{n} is the wife's marginal utility she derives from having children. The first order condition (4.10) shows the that the marginal utility of having children on the left hand side is equal to the marginal cost of providing childcare, which is the opportunity cost of not working in paid work, but the marginal cost can be reduced if she expects her husband to be helpful after childbirth indicated by a larger φZ_{ht-1}. On the other hand, if the husband did not perform as much housework in the previous stage, then the wife has to bear the full brunt of childcare and household responsibilities. Solving equations 4.9 and 4.10 for λ_w respectively gives the following equations:

$$\lambda_{w} = U^{w}_{x} / P_{wt}$$

$$\lambda_{w} = U^{w}_{n} / w_{wt}\, (\psi - \varphi Z_{ht-1})$$

Equating these two equations yields the wife's marginal rate of substitution (MRS) between children and private consumption:

$$MRS^{w}{}_{n,\,x} = \frac{U^{w}{}_{n}}{U^{w}{}_{x}} = \frac{w_{wt}(\psi - \varphi Z_{ht-1})}{P_{wt}} \qquad (4.12)$$

At optimal utility, the ratio of marginal utilities is equal to the ratio of their marginal costs.

The first order conditions 4.9-4.11 give rise to the wife's reaction function for the desired number of children (*n*) that is a function of the exogenous factors, namely her wage rate, the amount of childcare she expects her husband to perform given his previous contribution to housework and the vector of prices expressed as an implicit function below:

$$n^{*} = n(w_{wt},\, Z_{ht-1},\, P_{wt}) \qquad (4.13)$$

The number of children determines the amount of childcare time the wife has to perform given in equation (4.4). The next sections examine the effect of a change in the exogenous variables Z_{ht-1} and w_{wt} on the demand for children (*n*) using comparative statics.[30]

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30. We do not analyze changes in prices because inflation is not expected to have significant changes in developed countries.

4.3.1 Assessing the Impact of an Increase in
the Husband's Contribution to Housework

To evaluate the impact of an increase in the husband's contribution in housework in the first period (Z_{ht-1}) on the wife's demand for children and her private consumption, we totally differentiate the first order conditions 4.9-4.11 with respect to Z_{ht-1}.

$$U^w{}_{xx}\frac{\partial X_{wt}}{\partial Z_{ht-1}} - P_{wt}\frac{\partial \lambda_w}{\partial Z_{ht-1}} = 0$$

$$U^w{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} - \frac{\partial \lambda_w}{\partial Z_{ht-1}} w_{wt}\,(\psi - \varphi Z_{ht-1}) + \lambda_w w_{wt}\,\varphi = 0$$

$$P_{wt}\frac{\partial X_{wt}}{\partial Z_{ht-1}} + w_{wt}\frac{\partial n}{\partial Z_{ht-1}}(\psi - \varphi Z_{ht-1}) - w_{wt}\,n\,\varphi = 0 \qquad (4.14)$$

We can express the totally differentiated first order conditions in the matrix below.

$$\begin{bmatrix} U^w{}_{xx} & -P_{wt} & 0 \\ 0 & -w_{wt}(\psi - \varphi Z_{ht-1}) & U^w{}_{nn} \\ P_{wt} & 0 & w_{wt}(\psi - \varphi Z_{ht-1}) \end{bmatrix} \begin{bmatrix} \frac{\partial X_{wt}}{\partial Z_{ht-1}} \\ \frac{\partial \lambda_w}{\partial Z_{ht-1}} \\ \frac{\partial n}{\partial Z_{ht-1}} \end{bmatrix} = \begin{bmatrix} 0 \\ -\lambda_w w_{wt}\varphi \\ w_{wt} n\varphi \end{bmatrix} \qquad (4.15)$$

The Hessian determinant of the left hand side matrix is given by,

$$|H| = -\,U^w{}_{xx}\,w_{wt}^{\,2}\,(\psi - \varphi Z_{ht-1})^2 - P_{wt}^{\,2}\,U^w{}_{nn} > 0 \qquad (4.16)$$

$U^w{}_{xx} < 0$ and $U^w{}_{nn} < 0$ from (4.1). Prices and the wife's wage rate are positive, hence the Hessian determinant is positive.

Using Cramer's rule, in order to find the effect of the husband's time in housework on her demand for children, we substitute the right hand side vector in (4.15) for the third column of the left hand side matrix.

$$\frac{\partial n}{\partial Z_{ht-1}} = \frac{1}{|H|}\begin{bmatrix} U^w{}_{xx} & -P_{wt} & 0 \\ 0 & -w_{wt}(\psi - \varphi Z_{ht-1}) & -\lambda_w w_{wt}\varphi \\ P_{wt} & 0 & w_{wt} n\varphi \end{bmatrix}$$

$$= \frac{1}{|H|}[-U^w{}_{xx}\,w_{wt}(\psi - \varphi Z_{ht-1})\,w_{wt} n\varphi + (P_{wt})^2\,\lambda_w w_{wt}\varphi] > 0 \qquad (4.17)$$

The term ($\psi - \varphi Z_{ht-1}$) measures the wife's time required in childcare per child from (4.4), and it is clear that there cannot be a negative amount of time, hence $(\psi - \varphi Z_{ht-1}) > 0$. From (4.1), $U^w{}_{xx} < 0$, and since λ_w, w_{wt}, n, $\varphi > 0$ and the Hessian determinant is positive, the overall sign is positive. When the wife is married to a husband who does a fair amount of housework in the first stage depicted by a higher Z_{ht-1}, she believes he will participate in a substantial amount of childcare after childbearing (scaled by a positive constant φ). An increase in Z_{ht-1} increases her demand for children (n) because the opportunity cost of childcare w_{wt} $(\psi - \varphi Z_{ht-1})$ is now lower. This means that her demand for children is now higher as she substitutes away from private consumption as shown in the marginal rate of substitution given in (4.12). A higher Z_{ht-1} also means that she can increase her working hours in paid work and increase her income. Because she has more income under her control, her demand for children increases. Therefore, we predict that a woman married to a husband who contributed a higher amount of housework in the first stage (Z_{ht-1}) is unambiguously likely to have a higher demand for children.

The impact of an increase in Z_{ht-1} on the wife's private consumption using Cramer's rule is,

$$\frac{\partial x_{wt}}{\partial Z_{ht-1}} = \frac{1}{|H|}\begin{bmatrix} 0 & -P_{wt} & 0 \\ -\lambda_w w_{wt}\varphi & -w_{wt}(\psi - \varphi Z_{ht-1}) & U^w{}_{nn} \\ w_{wt} n\varphi & 0 & w_{wt}(\psi - \varphi Z_{ht-1}) \end{bmatrix}$$

$$= \frac{1}{|H|}\left[-\lambda_w w_{wt}{}^2\varphi(P_{wt})(\psi - \varphi Z_{ht-1}) - w_{wt} n\varphi(P_{wt} U^w{}_{nn})\right] \lesseqgtr 0 \quad (4.18)$$

Since $U^w{}_{nn} < 0$, $(\psi - \varphi Z_{ht-1}) > 0$ and λ_w, P_{wt}, w_{wt}, n, $\varphi > 0$, and the Hessian determinant is positive. The first term is negative and the second term is positive, so the overall sign is indeterminate. An increase in the husband's contribution to housework reduces the wife's private consumption (x_{wt}) because the opportunity cost of childcare (given by w_{wt} $(\psi - \varphi Z_{ht-1})$ in the first order condition (4.10) is now lower. This increases the demand for children causing a substitution effect away from consumption, as is shown in the marginal rate of substitution in 4.12. On the other hand, an increase in the husband's unpaid work increases the wife's private consumption because she can spend less time in childcare and more in paid work. She has more income under her control and therefore can consume more private goods causing an income effect. The overall effect on consumption depends on whether the income or the substitution effect dominates.

The impact of an increase in the husband's unpaid work on the lagrangian multiplier, the marginal utility of income using Cramer's rule is,

$$\frac{\partial \lambda_w}{\partial Z_{ht-1}} = \frac{1}{|H|}\begin{bmatrix} U^w{}_{xx} & 0 & 0 \\ 0 & -\lambda_w w_{wt}\varphi & U^w{}_{nn} \\ P_{wt} & w_{wt} n\varphi & w_{wt}(\psi - \varphi Z_{ht-1}) \end{bmatrix}$$

$$= \frac{1}{|H|} U^w{}_{xx}[-\lambda_w w_{wt}{}^2\varphi(\psi - \varphi Z_{ht-1}) - U^w{}_{nn}\, w_{wt} n\varphi] \lesseqgtr 0 \quad (4.19)$$

since $U^w_{nn} < 0$, $(\psi - \varphi Z_{ht-1}) > 0$ and λ_w, P_{wt}, w_{wt}, n, $\varphi > 0$. The first term in the square bracket is negative and the second term in the square bracket is positive. Since $U^w_{xx} < 0$ and |H|>0, the first term becomes positive and the second term becomes negative. The overall effect is indeterminate. Since the husband's unpaid work is higher, she can spend more time earning an income which reduces the marginal utility of income (which is the second term). But this effect can be offset by a larger incentive to increase private consumption and have more children which reduces income and thereby increasing the marginal utility of income.

The effects of an exogenous increase in the wife's wage rate at t on the endogenous variables n, x and λ_w are shown in the Appendix A and in summary, it predicts that:

$$\frac{\partial n}{\partial w_{wt}} \lesseqgtr 0, \frac{\partial x_w}{\partial w_{wt}} > 0, \ \frac{\partial \lambda_w}{\partial w_{wt}} < 0 \qquad (4.20)$$

A rise in the wage rate creates an income effect raising the demand for children. But it also causes a substitution effect because the opportunity cost of raising children is now higher. Therefore, the demand for children falls, while the demand for consumption rises. Hence, the overall effect on the demand for children is indeterminate. The effect on consumption is positive because the opportunity cost of childcare is higher, therefore the wife substitute towards consumption as also shown by the MRS in (4.12). The effect on the lagrangian multiplier or the marginal utility of income is negative because the wife has more income under her control.

4.4 Stage One: Husband's Housework

In the first stage, the couple has no children and the husband, as the Stackelberg leader, maximizes his utility based on his time and budget constraints and the wife's reaction function (4.12). Akerlof (1980) introduced the idea that a belief in specific codes of behavior and the pressure to obey them play in explaining the persistence of social custom. Kevane and Wydick (2001) and Fletschner and Carter (2008) introduce more formally the role of social norms in determining women's time allocation and women's investment decisions, respectively. Kevane and Wydick (2001) study how social norms affect women's allocation in housework, farm work and paid wage work, but they do not consider the husband's time allocation decisions. In contrast, we assume that the husband's time allocation decision depends on his perception of socially determined norms about men's roles in housework.

The husband's total utility V_h is a function of the number of children (n), his own consumption (x_{ht-1}) and a social-norm based disutility that a person experiences by deviating from accepted social norms and behavior (Fletschner and Carter 2008). Social-norm based disutility is the second term in (4.21) using the formulation by Fletschner and Carter (2008).[31]

$$V_h = U^h(n, x_{ht-1}) - \frac{1}{2}\alpha\,(|Z_{ht-1} - Z^e_{ht-1}|)^2 \qquad (4.21)$$

Where $U^h_n > 0$, $U^h_x > 0$, and marginal utility is diminishing in its argument, $U^h_{nn} < 0$, $U^h_{xx} < 0$ and $0 \leq \alpha < 1$. As before, we assume that the utility is separable in x_{wt} and n, namely that $U^h_{xn} = 0$, $U^h_{nx} = 0$. Z^e_{ht-1} is defined as the amount of housework the husband's perceives to be acceptably performed by men. We assume that the husband's behavior, in and of itself, does not significantly affect his peer's behavior, hence Z^e_{ht-1} is assumed to be exogenous.[32] Rather, Z^e_{ht-1} is determined by social norms, social institutions or the behavior of a specific group of people about the gender roles in housework (Fletchner and Carter 2008).[33] It should be noted that this is the husband's perceived level of housework, and not the actual average amount of housework that is important, hence a more traditional man believes that the socially accepted level of Z^e_{ht-1} to be lower than a more open minded person. Fletschner and Carter (2008) define this to be determined by his initial belief regarding gender roles (in housework) and this is updated by observing the behavior of the people around him. Hence, the husband's perception of gender roles reflects his interpretation of his childhood environment which could differ from region to region, or due to his childhood family composition or socio-economic condition.[34] The updating of his beliefs could be determined by the

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31. Our formulation of the utility function is the same as Fletchner and Carter (2008) with the exception of the constant ½ which is borrowed from Kevane and Wydick (2001). Kevane and Wydick (2001) study women's time allocation decisions in which a household maximizes a production function subject to the wife's time constraints. They incorporate the benefits of conforming to social norms to production that is independent of the time spent by the women. In contrast, Fletchner and Carter (2008)'s definition has the advantage of allowing the deviation from the norms to cause a disutility.

32. Fletchner and Carter (2008) analyze the case that the term could be endogenous, where one's behavior could affect your peer's behavior creating a multiplier effect.

33. Fletchner and Carter (2008) formulate this term as the social norms about women's investment in certain activities, rather than unpaid work.

34. For example, if the husband's mother worked during his childhood, he may be expected to perform housework and consequently be more open to men contributing in the household. The husband may have an older sister who was expected to help out much more than himself. This could affect his perceptions of gender norms.

environment in which he currently lives such as whether he lives in a large metropolitan area or in a rural area. The deviation from the norms expressed by the term, ($|Z_{ht-1} - Z^e_{ht-1}|$), creates a disutility and the size of the disutility is dependent on the level of the punishment for not conforming to the norms. Note that the absolute value of deviating from the norms creates a disutility irrespective of whether $Z_{ht-1} > Z^e_{ht-1}$, or $Z_{ht-1} < Z^e_{ht-1}$. The severity of punishment for not conforming to norms is expressed by the magnitude of a positive constant term α, where $0 \leq \alpha < 1$ (Fletschner and Carter 2008, Kevane and Wydick 2001).[35] For example, a man in a tight-knit community where people know their neighbors may feel the pressure to conform to his neighbor's behavior indicating a larger α, whereas a man in an urban setting where he doesn't know his neighbors may not feel a similar pressure indicated by a smaller α (Fletschner and Carter 2008).

We define the husband's total utility V_h to be quasi-concave in Z_{ht-1} and x_{ht-1}, which is a sufficient condition to find a local maximum (Nicolson 2005). This requires that the value of Z_{ht-1} has to satisfy the condition that V_h is increasing in Z_{ht-1} and that the marginal utility of Z_{ht-1} is diminishing in Z_{ht-1}, and similarly for x_{ht-1}.[36] Since the husband has the first mover advantage and he knows his wife's reaction function, we substitute her reaction function into his utility function 4.21. The value of Z_{ht-1} has to satisfy the following the first and second order derivatives with respect to Z_{ht-1}:

$$\partial V_h/\partial Z_{ht-1} = U^h{}_n \frac{\partial n}{\partial Z_{ht-1}} - \alpha\, |Z_{ht-1} - Z^e{}_{ht-1}| > 0$$

and

$$\partial V_h{}^2/\partial Z_{ht-1}{}^2 = U^h{}_{nn} \frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n \frac{\partial^2 n}{\partial Z_{ht-1}{}^2} - \alpha < 0 \qquad (4.22)$$

The husband's total utility function is shaped like the top half of a circle because at some value of Z_{ht-1}, the utility starts to decline with Z_{ht-1}. The value of Z_{ht-1} will not be in the range where $\partial V_h/\partial Z_{ht-1} < 0$, because the marginal utility of Z_{ht-1} is negative. This means that the value of Z_{ht-1} will lie between 0 and some value $\check{Z}$ at which the marginal utility is zero, i.e. at $\partial V_h/\partial Z_{ht-1} = 0$.

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35. When $\alpha = 0$, there is no punishment for not conforming to social norms and the utility function reverts to a neoclassical utility function.

36. For x_{ht-1}, this condition is clear from 4.21.

We know from 4.17 that $\partial n / \partial Z_{ht-1} > 0$, $U^h{}_n > 0$ and $U^h{}_{nn} < 0$ from 4.21 and $\partial^2 n / \partial Z_{ht-1}{}^2 > 0$ as shown in Appendix B, then the second inequality of 4.22 ($\partial V_h{}^2 / \partial Z_{ht-1}{}^2$) implies that:

$$U^h{}_n \frac{\partial^2 n}{\partial Z_{ht-1}{}^2} < - U^h{}_{nn} \frac{\partial n}{\partial Z_{ht-1}} + \alpha \quad (4.23)$$

Where both sides of the inequality are positive.

The husband's budget constraint is given by:

$$P_{ht-1}\, x_{ht-1} = w_{ht-1}\, l_{ht-1} - \Phi \quad (4.24)$$

Where P_{ht-1} is a vector of prices, w_{ht-1} is the husband's wage rate, both of which are assumed to be exogenous. As discussed before, Φ is the transfer that the husband gives to his wife and we assume that this is exogenously determined by social norms. l_{ht-1} is the amount of time the husband spends in paid work.

His time constraint is:

$$l_{ht-1} + Z_{ht-1} \leq T_h \quad (4.25)$$

Where Z_{ht-1} is the time the husband spends in unpaid work and T_h is the total time available minus time for basic maintenance (e.g. sleeping or eating).

The husband maximizes his utility (4.21) by choosing levels of consumption (x_{ht-1}) and unpaid work (Z_{ht-1}), subject to his budget and time constraints (4.24 and 4.25) and his wife's reaction function (by substituting his wife's reaction function (4.13) into the utility function (4.21)). We obtain the following Lagrangian function for the husband:

$$L_h = U^h(n(w_{wt}, \varphi Z_{ht-1}), x_{ht-1}) - \frac{1}{2}\alpha\, (|Z_{ht-1} - Z^e{}_{ht-1}|)^2 + \lambda_h [- P_h\, x_{ht-1} + w_{ht-1}\, (T_h - Z_{ht-1}) - \Phi] \quad (4.26)$$

Differentiating (4.26) with respect to x_{ht-1}, Z_{ht-1} and λ_h gives the following first order conditions,

$$U^h{}_x = \lambda_h\, P_{ht-1} \quad (4.27)$$

$$U^h{}_n\, (\partial n / \partial Z_{ht-1}) = \alpha\, |Z_{ht-1} - Z^e{}_{ht-1}| + \lambda_h\, w_{ht-1} \quad (4.28)$$

$$P_{ht-1}\, x_{ht-1} - w_{ht-1}\, (T_h - Z_{ht-1}) + \Phi \leq 0 \quad (4.29)$$

From Kuhn-Tucker condition, $\lambda_h \geq 0$.

Note that $U^h{}_n$ husband's marginal utility of children, $\partial n / \partial Z_{ht-1}$ is the change in the wife's demand for children caused by a change in the husband's unpaid work (Z_{ht-1}) from 4.17, and $U^h{}_x$ is the husband's marginal utility of x_{ht-1}. The husband's marginal benefit of contributing more housework is realized by his wife having more children (through her reaction function, $\partial n / \partial Z_{ht-1}$), which in turn, increases his utility on the left hand side in (4.28). He increases his housework until the marginal benefit (i.e. the left hand side of 4.28) is equal to the marginal cost of performing housework which is the sum of the marginal disutility he experiences by deviating from social norms and the opportunity cost of housework (i.e. of not working in paid work) on the right hand side in (4.28). As mentioned before, the deviation from the social norm always causes a disutility, and hence the term $|Z_{ht-1} - Z^e_{ht-1}|$ is an absolute value, i.e. $|Z_{ht-1} - Z^e_{ht-1}| \geq 0$.

Solving equations 4.27 and 4.28 for λ_h and equating them gives the husband's marginal rate of substitution between housework (Z_{ht-1}) and his private consumption (x_{ht-1}),

$$MRS^h_{z,x} = \frac{U^h{}_n \frac{\partial n}{\partial Z_{ht-1}} - \alpha\,|Z_{ht-1} - Z_{ht-1}{}^e|}{U^h{}_x} = \frac{w_{ht-1}}{P_{ht-1}} \quad (4.30)$$

At utility maximization, the husband chooses the amount of housework (Z_{ht-1}) and consumption (x_{ht-1}) that equates the ratio of the marginal utility from housework he derives by having more children minus the disutility he experiences from deviating from the norm over the marginal utility of consumption, to the ratio of his wage over the prices.[37] This conclusion is similar to the standard prediction that an individual consumes a bundle of goods until the ratio of the marginal utilities is equal to the ratio of their prices. However, the innovation in this model is the inclusion of the disutility term the husband experiences from deviating from the norm, namely $\alpha\,|Z_{ht-1} - Z_{ht-1}{}^e|$.

It is important to mention that we assume that the intra-household financial transfers from the husband to the wife (Φ) are exogenously given and it is not affected by the husband's time allocation decisions. For example, a rise in the husband's time spent on housework (Z_{ht-1}) reduces his income as seen from his budget constraint 4.29. However, because the transfers are exogenously given, this is not expected to reduce his transfers to his wife. This may be a strong assumption, and we could foresee the possibility that a reduction in his income (as a result of spending more time in housework) reduces the transfers to his wife. The implications of relaxing the exogeneity assumption of Φ are discussed later in this Chapter.

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37. The condition in 4.22, namely $U^h{}_{nn} \frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n \frac{\partial^2 n}{\partial Z_{ht-1}{}^2} - \alpha < 0$ ensures that the $MRS_{z,x}$ is diminishing in Z_{ht-1}, which is required for the indifference curve between Z_{ht-1} and x_{ht-1} to be convex (Nicholson 2005). To see why, differentiating $MRS_{z,x}$ with respect to Z_{ht-1} gives $\frac{\partial MRS_{z,x}}{\partial Z_{ht-1}} = \frac{U^h{}_x [U^h{}_{nn} \frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n \frac{\partial^2 n}{\partial Z_{ht-1}{}^2} - \alpha]}{(U^h{}_x)^2} < 0$. The sign is negative from 4.22.

4.4.1 Assessing Impact of an Exogenous
Rise in His Perception of Social Norms

We will see below that a difference in the husband's perception about acceptable levels of housework performed by men $Z^e{}_{ht-1}$ could result in different optimal levels of Z_{ht-1}. Two individuals who possess the same characteristics would spend different amounts of housework if each has different perception of the social norms regarding men's housework. This could arise because they grew up in different social or family environment where norms were different. To see how this affects housework, totally differentiating the first order conditions (4.27-4.29) with respect to $Z^e{}_{ht-1}$, where his choice variables are his consumption (x_{ht-1}), housework (Z_{ht-1}) and the lagrangian multiplier (λ_h), gives,

$$U^h{}_{xx}\frac{\partial x_{ht-1}}{\partial Z_{ht-1}{}^e} - \frac{\partial \lambda_h}{\partial Z_{ht-1}{}^e}P_{ht-1} = 0$$

$$U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}}\frac{\partial Z_{ht-1}}{\partial Z_{ht-1}{}^e} + U^h{}_n\frac{\partial^2 n}{\partial Z_{ht-1}{}^2}\frac{\partial Z_{ht-1}}{\partial Z_{ht-1}{}^e} - \alpha\frac{\partial Z_{ht-1}}{\partial Z_{ht-1}{}^e} - \frac{\partial \lambda_h}{\partial Z_{ht-1}{}^e}w_{ht-1} = -\alpha$$

$$P_{ht-1}\left(\frac{\partial x_{ht-1}}{\partial Z_{ht-1}{}^e}\right) + w_{ht-1}\frac{\partial Z_{ht-1}}{\partial Z_{ht-1}{}^e} = 0 \qquad (4.31)$$

Expressing the totally differentiated first order conditions in a matrix form is shown as,

$$\begin{bmatrix} U^h{}_{xx} & 0 & -P_{ht-1} \\ 0 & U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n\frac{\partial^2 n}{\partial Z_{ht-1}{}^2} - \alpha & -w_{ht-1} \\ P_{ht-1} & w_{ht-1} & 0 \end{bmatrix}\begin{bmatrix} \frac{\partial x_{ht-1}}{\partial Z_{ht-1}{}^e} \\ \frac{\partial Z_{ht-1}}{\partial Z_{ht-1}{}^e} \\ \frac{\partial \lambda_h}{\partial Z_{ht-1}{}^e} \end{bmatrix} = \begin{bmatrix} 0 \\ -\alpha \\ 0 \end{bmatrix} \qquad (4.32)$$

The Hessian determinant is given by,

$$|H| = U^h{}_{xx}w_{ht-1}{}^2 + P_{ht-1}{}^2 U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n\frac{\partial^2 n}{\partial Z_{ht-1}{}^2} - \alpha < 0 \qquad (4.33)$$

Since $U^h{}_{xx} < 0, U^h{}_{nn} < 0$, $\frac{\partial n}{\partial Z_{ht-1}} > 0$ from the wife's reaction function 4.16 and $U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n\frac{\partial^2 n}{\partial Z_{ht-1}{}^2}$ $- \alpha < 0$ from 4.22. Hence the Hessian determinant is negative.

Using Cramer's rule, inserting the right hand side vector into the second column of matrix in 4.32 gives:

$$\frac{\partial Z_{ht-1}}{\partial Z_{ht-1}{}^e} = \frac{1}{|H|}\begin{bmatrix} U^h{}_{xx} & 0 & -P_{ht-1} \\ 0 & -\alpha & -w_{ht-1} \\ P_{ht-1} & 0 & 0 \end{bmatrix}$$

$$= \frac{1}{|H|}(-\alpha P_{ht-1}{}^2) > 0 \qquad (4.34)$$

Since the Hessian determinant is negative from 4.33, the overall effect is positive. A man who believes that men should actively participate in housework (i.e. a higher $Z^e{}_{ht-1}$) will therefore allocate more time to this activity, compared to a person who believes that women should bear the household responsibilities and men should not help out in housework, all else equal. Consequently, a man with a higher $Z^e{}_{ht-1}$ spends more time in housework, has more children (based on his wife's reaction function) and will obtain a higher level of the utility.

The impact of a higher level of $Z^e{}_{ht-1}$ on private consumption is shown by,

$$\frac{\partial X_{ht-1}}{\partial Z_{ht-1}{}^{e}} = \frac{1}{|H|}\begin{bmatrix} 0 & 0 & -P_{ht-1} \\ -\alpha & U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_{n}\frac{\partial^2 n}{\partial Z_{ht-1}{}^{2}} - \alpha & -w_{ht-1} \\ 0 & w_{ht-1} & 0 \end{bmatrix}$$

$$= \frac{1}{|H|}\alpha w_{ht-1}\, P_{ht-1} < 0 \qquad (4.35)$$

Since the Hessian determinant is negative from 4.33, the overall effect is negative. A rise in the husband's perception about social norms on housework reduces the disutility of deviating from the norm if $Z_{ht-1} > Z^e{}_{ht-1}$, or increases the disutility if $Z_{ht-1} < Z^e{}_{ht-1}$. From the husband's marginal rate of substitution 4.30, this causes him to allocate more time to housework and substitute away from private consumption.

The effect on the lagrangian multiplier is,

$$\frac{\partial \lambda_h}{\partial Z_{ht-1}{}^{e}} = \frac{1}{|H|}\begin{bmatrix} U^h{}_{xx} & 0 & 0 \\ 0 & U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_{n}\frac{\partial^2 n}{\partial Z_{ht-1}{}^{2}} - \alpha & -\alpha \\ P_{ht-1} & w_{ht-1} & 0 \end{bmatrix}$$

$$= \frac{1}{|H|}U^h{}_{xx}\alpha w_{ht-1} > 0 \qquad (4.36)$$

Someone with a higher $Z^e{}_{ht-1}$ is expected to spend more in unpaid work as discussed above which reduces his income because he spends less time in paid work, causing the marginal utility of income to rise.

4.4.2. Assessing the Impact of a Change in Punishment from Deviating from Social Norms

The punishment from deviating from social norms is represented by a constant α. In our model, this is determined by the social environment in which he lives. For example, a person who lives in a tightly knit community where people know each other is likely to have more pressure conform to their neighbors' behavior (Fletchner and Carter 2008). On the other hand, a person in a metropolitan area may not have much contact with their neighbors and consequently do not feel as much pressure to conform to their actions. We look at the impact of a rise in α by totally differentiating the first order conditions (4.27-4.29) with respect to α giving the following equations.

$$U^h_{xx}\frac{\partial X_{ht-1}}{\partial \alpha} - \frac{\partial \lambda_h}{\partial \alpha} P_{ht-1} = 0$$

$$U^h_{nn}\frac{\partial n}{\partial Z_{ht-1}}\frac{\partial Z_{ht-1}}{\partial \alpha} + U^h_n\frac{\partial^2 n}{\partial {Z_{ht-1}}^2}\frac{\partial Z_{ht-1}}{\partial \alpha} - \alpha\frac{\partial Z_{ht-1}}{\partial \alpha} - \frac{\partial \lambda_h}{\partial \alpha} w_{ht-1} = |Z_{ht-1} - {Z_{ht-1}}^e|$$

$$P_{ht-1}\frac{\partial X_{ht-1}}{\partial \alpha} + w_{ht-1}\frac{\partial Z_{ht-1}}{\partial \alpha} = 0 \qquad (4.37)$$

This can be expressed in matrix form below,

$$\begin{bmatrix} U^h{}_{xx} & 0 & -P_{ht-1} \\ 0 & U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n\frac{\partial^2 n}{\partial {Z_{ht-1}}^2} - \alpha & -w_{ht-1} \\ P_{ht-1} & w_{ht-1} & 0 \end{bmatrix}\begin{bmatrix} \frac{\partial X_{ht-1}}{\partial \alpha} \\ \frac{\partial Z_{ht-1}}{\partial \alpha} \\ \frac{\partial \lambda_h}{\partial \alpha} \end{bmatrix} = \begin{bmatrix} 0 \\ |Z_{ht-1} - {Z_{ht-1}}^e| \\ 0 \end{bmatrix} \qquad (4.38)$$

The Hessian determinant is given by,

$$|H| = U^h{}_{xx}{w_{ht-1}}^2 + {P_{ht-1}}^2[U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n\frac{\partial^2 n}{\partial {Z_{ht-1}}^2} - \alpha] < 0 \qquad (4.39)$$

Since $U^h_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h_n\frac{\partial^2 n}{\partial {Z_{ht-1}}^2} - \alpha < 0$ from 4.22, the overall sign is negative.

The effect of a rise in the punishment for not conforming to social norms on the husband's time in housework (Z_{ht-1}) is shown by,

$$\frac{\partial Z_{ht-1}}{\partial \alpha} = \frac{1}{|H|}\begin{bmatrix} U^h{}_{xx} & 0 & -P_{ht-1} \\ 0 & |Z_{ht-1} - {Z_{ht-1}}^e| & -w_{ht-1} \\ P_{ht-1} & 0 & 0 \end{bmatrix}$$

$$= \frac{1}{|H|}({P_{ht-1}}^2|Z_{ht-1} - {Z_{ht-1}}^e|) < 0 \qquad (4.40)$$

Since the Hessian determinant is negative from 4.40, the overall effect is negative. A rise in the punishment for deviating from social norms (α) increases the disutility from doing so. This has the effect of reducing the husband's contribution to housework.

The effect of a rise in α on the husband's consumption (x_{ht-1}) is shown below.

$$\frac{\partial X_{ht-1}}{\partial \alpha} = \frac{1}{|H|}\begin{bmatrix} 0 & 0 & -P_{ht-1} \\ |Z_{ht-1} - {Z_{ht-1}}^e| & U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n\frac{\partial^2 n}{\partial {Z_{ht-1}}^2} - \alpha & -w_{ht-1} \\ 0 & w_{ht-1} & 0 \end{bmatrix}$$

$$= \frac{1}{|H|}(-w_{ht-1}P_{ht-1}|Z_{ht-1} - Z_{ht-1}{}^{e}|) > 0 \qquad (4.41)$$

The overall sign is positive because the Hessian determinant is negative. When the punishment for not conforming to the norm is larger, this causes a substitution away from allocating time in housework leading to a higher demand for consumption, as shown in the husband's marginal rate of substitution 4.30.

The effect on the lagrangian multiplier is,

$$\frac{\partial\lambda_h}{\partial\alpha} = \frac{1}{|H|}\begin{bmatrix} U^h{}_{xx} & 0 & 0 \\ 0 & U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n\frac{\partial^2 n}{\partial Z_{ht-1}{}^2} - \alpha & |Z_{ht-1} - Z_{ht-1}{}^{e}| \\ P_{ht-1} & w_{ht-1} & 0 \end{bmatrix}$$

$$= \frac{1}{|H|}U^h{}_{xx}(-|Z_{ht-1} - Z_{ht-1}{}^{e}|w_{ht-1}) < 0 \qquad (4.42)$$

The overall sign is negative since $|H|<0$ and $U^h{}_{xx} < 0$. This suggests that a rise in the punishments towards those that deviate from the norms (i.e. a rise in α) reduces the husband's time allocated to housework and increases the time allocated to paid work which increases his income. Consequently, the marginal utility of income is reduced.

4.5 Summary of the Comparative Statics Results

The Table 4.1 provides the main summary of the comparative statics discussed in the proceeding sections focusing on the husband's time spent in housework and the wife's demand for children. The change in the husband's perception of norms ($Z^e{}_{ht-1}$) or in the penalty for not conforming to the norms (α) affect his time spent in housework in the first period. This, in turn, affects his wife's demand for children. The husband's time allocated to unpaid work can be low if he strongly believes in the gender assigned household responsibilities that women should take on the bulk of housework (i.e. $Z^e{}_{ht-1}$ is low), or if the penalty for not conforming to social norms is high (i.e. α is high). The wife then reacts to his low contribution to housework by wanting to have fewer children because she believes that he will not be a helpful father once the children are born. The effect of a rise in the husband's wage rate at *t-1* (w_{ht-1}) causes an income effect increasing Z_{ht-1}, but it can be offset by a substitution effect by working longer in paid work and reducing Z_{ht-1}.[38] This subsequently has a positive or negative effect on the wife's demand for

38. Comparative statics are shown in Appendix C.

children at t depending on the sign of Z_{ht-1}. Similarly, the wife's wage rate at t (w_{wt}) causes an income effect increasing demand for children, and a substitution effect reducing demand for children.

In the above model, we saw that the husband, as the Stackelberg leader, chooses the optimal level of housework Z_{ht-1} based on his wife's reaction function, his perception about norms on gender roles in housework and the severity of punishment for not conforming to the norm. The wife, as the follower,

Table 4.1. Comparative Statics with Exogenous Intra-Household Transfers

Exogenous change:	Impact on: husband's time allocated to housework at t-1 (Z_{ht-1})	Impact on: Wife's demand for children at t (n)
A fall in Z^e_{ht-1}	(-)	(-)
An increase in α	(-)	(-)
An increase in w_{ht-1}	(+/-)	(+/-)
An increase in w_{wt}		(+/-)

Note: (+) denotes a positive effect and (-) denotes a negative effect.

determines how many children she wants to have taking as given her husband's contribution to housework in the previous period Z_{ht-1}. The comparative statics show that the higher the husband's perception about social norms on men's contribution to housework, the more likely he is to allocate time to this activity. The more severe the punishment from deviating from the social norms, the more constrained his contribution to housework would be. The wife responds by determining how many children she wants according her husband's contribution in the previous period. The more helpful the husband was (indicated by higher Z_{ht-1}), the higher her demand for children.

We empirically test the prediction that the husband's contribution to housework increases the wife's demand for children in the Chapters 5 and 6. An increase in the wife's demand for children, through a rise in the husband's time in housework, is likely to increase the probability that the couple has a child in subsequent periods. The model also predicts that factors that inhibit his contribution to housework, such as the husband's childhood environment including the regions he grew up, or the current environment in which he lives (e.g. living in a rural area vs. metropolitan city), could influence his perception of social norms and the severity of punishment he feels for not conforming to these norms. These factors are likely affect his time allocated to housework.

4.6 The Case of Endogenously Determined Intrahousehold Financial Transfers (Φ)

In this section, we relax the assumption that the level of intra-household transfers from the husband to the wife (Φ) is exogenously determined by social norms. Instead, we make two assumptions: 1) the husband determines the level of transfers as a fixed proportion of his income, β at time t-1; and 2) he gives the financial transfers to his wife in t. Hence, there is a time lag between the time he determines the amount, and when he transfers it to his wife. In contrast to sections 4.1-4.5, the transfers are now endogenous to the husband's decisions at t-1, but are exogenous to the wife's decisions at t. The transfers are given by the following equation:

$$\Phi_{t-1} = w_{ht-1}\,(T_h - Z_{ht-1})\beta \qquad (4.6.1)$$

Where $0 < \beta < 1$, w_{ht-1} is the exogenous husband's wage at t-1, Z_{ht-1} is the husband's time spent in housework at t-1 and T is the time the husband has available net of maintaining himself such as sleeping and eating. We assume that the term β is a fixed constant and we follow the assumptions made by the collective models by Chiappori (1988) and Apps and Rees (1996) on intra-household allocation and division of labor. However, the notable difference is that they assume that a household maximize their utility and allocation decisions are given by the exogenously given sharing rule.

As before, since the wife is the follower, we develop the wife's reaction function first. The financial transfers from the husband (Φ_{t-1}) are exogenous to the wife's decision in t since the husband already determined this amount in the previous period. Substituting 4.6.1 into the wife's budget constraint (4.5) yields:

$$P_{wt}\, x_{wt} \leq w_{wt}\,[T_w - (\psi - \varphi Z_{ht-1})n] + w_{ht-1}\,(T_h - Z_{ht-1})\beta \qquad (4.6.2)$$

The lagrangian equation can now be expressed as:

$$L_w = U^w(x_{wt}, n) + \lambda_w\,[\, - P_{wt}\, x_{wt} + w_{wt}\{T_w - (\psi - \varphi Z_{ht-1})n\} + w_{ht-1}\,(T_h - Z_{ht-1})\beta\,] \qquad (4.6.3)$$

Where λ_w is the lagrangian multiplier on the budget constraint.

Maximizing utility subject to the constraints where the endogenous variables are x_{wt} , n and λ_w gives the following first order conditions:

$$U^w_x = \lambda_w P_{wt} \qquad (4.6.4)$$

$$U^w_n = \lambda_w w_{wt} (\psi - \varphi Z_{ht-1}) \qquad (4.6.5)$$

$$P_{wt} x_{wt} \leq w_{wt} [T_w-(\psi - \varphi Z_{ht-1})n] + w_{ht-1} (T_h- Z_{ht-1})\beta \qquad (4.6.6)$$

The first order conditions are almost the same as before, except that the budget constraint shows that her husband's time in housework, Z_{ht-1} has two opposing effects. It increases her total income because she can spend more time in the labor market (since she believes he will be more helpful once the children are born). However, Z_{ht-1} also reduces her income because he reduces his transfers due to the husband's opportunity cost of housework and the lost earnings at *t-1*.

4.6.1 Comparative Statics: Assessing the Impact of a larger Z_{ht-1}

To evaluate the impact of a larger contribution from the husband in the first period on the endogenous variables, namely the wife's demand for children, we totally differentiate the first order conditions 4.6.4-4.6.6 with respect to Z_{ht-1}.

$$U^w{}_{xx} \frac{\partial x_{wt}}{\partial Z_{ht-1}} - P_{wt} \frac{\partial \lambda_w}{\partial Z_{ht-1}} = 0$$

$$U^w{}_{nn} \frac{\partial n}{\partial Z_{ht-1}} - \frac{\partial \lambda_w}{\partial Z_{ht-1}} w_{wt} (\psi - \varphi Z_{ht-1}) + \lambda_w w_{wt} \varphi = 0$$

$$P_{wt} \frac{\partial x_{wt}}{\partial Z_{ht-1}} + w_{wt} \frac{\partial n}{\partial Z_{ht-1}} (\psi - \varphi Z_{ht-1}) - w_{wt}\, n\, \varphi + w_{ht-1} \beta = 0 \qquad (4.6.7)$$

We can express the totally differentiated first order conditions in the matrix below.

$$\begin{bmatrix} U^w{}_{xx} & 0 & -P_{wt} \\ 0 & U^w{}_{nn} & -w_{wt}\left(\psi - \varphi Z_{ht-1}\right) \\ P_{wt} & w_{wt}(\psi - \varphi Z_{ht-1}) & 0 \end{bmatrix} \begin{bmatrix} \frac{\partial x_{wt}}{\partial Z_{ht-1}} \\ \frac{\partial n}{\partial Z_{ht-1}} \\ \frac{\partial \lambda_w}{\partial Z_{ht-1}} \end{bmatrix} = \begin{bmatrix} 0 \\ -\lambda_w w_{wt} \varphi \\ w_{wt} n \varphi - w_{ht-1} \beta \end{bmatrix} \qquad (4.6.8)$$

The Hessian determinant of the left hand side matrix is given by,

$$|H| = U^w{}_{xx}\, w_{wt}{}^2 (\psi - \varphi Z_{ht-1})^2 + P_{wt}{}^2\, U^w{}_{nn} < 0 \qquad (4.6.9)$$

Since $U^w_{xx} < 0$ and $U^w_{nn} < 0$ from (4.1), prices and the wife's wage rate are positive, hence the Hessian determinant is negative.

To find the effect of the husband's time in housework on her demand for children, we use Cramer's rule and substitute the right hand side vector in (4.6.8) for the second column of the left hand side matrix.

$$\frac{\partial n}{\partial Z_{ht-1}} = \frac{1}{|H|} \begin{bmatrix} U^{w}{}_{xx} & 0 & -P_{wt} \\ 0 & -\lambda_w w_{wt} \varphi U^{w}{}_{nn} & -w_{wt}(\psi - \varphi Z_{ht-1}) \\ P_{wt} & w_{wt} n\varphi - w_{ht-1}\beta & 0 \end{bmatrix}$$

$$= \frac{1}{|H|} [U^{w}{}_{xx}\, w_{wt}(\psi - \varphi Z_{ht-1})\,(w_{wt} n\varphi - w_{ht-1}\beta) - (P_{wt})^2 \lambda_w w_{wt}\varphi \qquad (4.6.10)$$

We know that |H|<0 from (4.6.9), and $U^{w}{}_{xx} < 0$ from (4.1) and $(\psi - \varphi Z_{ht-1}) > 0$ from (4.6.4).

We cannot determine the sign of the comparative static without making further assumptions regarding the relative wages between the husband and wife and the relative wage price ratio. We examine three possibilities which we call Gender Wage Equality scenario; Unequal Power and Low Real Wage Rate; and Unequal Power and High Real Wage Rate.

Gender Wage Equality Scenario

In the first instance, if $w_{wt}\, n\, \varphi - w_{ht-1}\, \beta > 0$, then:

$$\frac{\partial n}{\partial Z_{ht-1}} = \frac{1}{|H|} [U^{w}{}_{xx}\, w_{wt}(\psi - \varphi Z_{ht-1})\,(w_{wt} n\varphi - w_{ht-1}\beta) - (P_{wt})^2 \lambda_w w_{wt}\varphi] > 0 \qquad (4.6.11)$$

Because |H|<0 and $U^{w}{}_{xx} < 0$, the overall sign is positive.

In order to make an economic interpretation of the inequality $w_{wt}\, n\, \varphi - w_{ht-1}\, \beta > 0$, we rearrange the first order condition (4.6.6), which is the wife's budget constraint, as:

$$P_{wt}\, x_{wt} + w_{wt}\, \psi n + Z_{ht-1}(w_{ht-1}\, \beta - w_{wt}\, n\, \varphi) \le w_{wt}\, T_w + w_{ht-1}\, T_h\, \beta \qquad (4.6.6)'$$

The left hand side of 4.6.6' can be viewed as the total expenditure and the right hand side can be viewed as full income (Becker 1991). From 4.6.6', $w_{ht-1}\, \beta$ is the marginal reduction in the wife's income due to a unit increase in Z_{ht-1}. This occurs because an hour increase in the husband's housework at *t-1* (Z_{ht-1}) causes his income at *t-1* to fall by w_{ht-1} since he works one hour less in paid work. As a result, he reduces the financial transfers he gives to his wife by $w_{ht-1}\, \beta$. Whereas $w_{wt}\, n\, \varphi$ is the marginal increase in the wife's income due a unit increase in Z_{ht-1}. She is able to work longer in paid work because she expects her husband to take on more housework at *t* which increases her income at *t* by $w_{wt}\, n\, \varphi$. The inequality $w_{wt}\, n\, \varphi - w_{ht-1}\, \beta > 0$ implies that a unit increase in Z_{ht-1} causes a net increase in the wife's income because the rise in income from her working longer is greater than the loss of income from the fall in transfers from her husband.

From 4.3, $\varphi > 0$ and from 4.6.2, $1 > \beta > 0$. The inequality $w_{wt}\, n\, \varphi - w_{ht-1}\, \beta > 0$ is likely to hold when one or more of the following conditions apply: 1) her wage rate (w_{wt}) is high relative to her husband's wage rate w_{ht-1}; 2) if husband's wage rate is higher than his wife's $w_{ht-1} > w_{wt}$, the difference in wage gap between the spouses ($w_{ht-1} - w_{wt}$) is sufficiently small such that $w_{wt}\, n\, \varphi - w_{ht-1}\, \beta > 0$ holds; 3) when the fixed coefficient φ is high (which signifies how much the wife expects her husband to contribute to childcare based on his previous housework contribution); and 4) when the exogenous proportion of transfers to his wife β is low.

We can call this scenario a gender wage equality case because this is likely to occur when the wage gap between the spouses, $w_{ht-1} - w_{wt}$, is small, or the wife's wage rate is high relative to her husband's wage rate. In such a case, the rise in the husband's housework at *t-1* increases the wife's demand for children because Z_{ht-1} causes a net increase in the wife's income.

<u>Unequal Power and Low Real Wage Rate Scenario</u>

$$\text{If } (w_{wt}\, n\, \varphi - w_{ht-1}\, \beta) < 0, \qquad (4.6.12)$$

$$\text{and } [U^{w}{}_{xx}\, w_{wt}\big(\psi - \varphi Z_{ht-1}\big)\,(w_{wt} n\varphi - w_{ht-1}\beta)] < (P_{wt})^2\, \lambda_w w_{wt}\varphi\,, \qquad (4.6.13)$$

Since $U^{w}_{xx} < 0$ and by assumption, $(w_{wt}\, n\, \varphi - w_{ht-1}\, \beta) < 0$, both sides of 4.6.13 are positive. The economic interpretation of the inequalities is discussed shortly.

Then the following inequality holds:

$$\frac{\partial n}{\partial Z_{ht-1}} = \frac{1}{|H|}[U^{w}{}_{xx}\, w_{wt}\big(\psi - \varphi Z_{ht-1}\big)\,(w_{wt} n\varphi - w_{ht-1}\beta) - (P_{wt})^2\, \lambda_w w_{wt}\varphi] > 0 \qquad (4.6.14)$$

Because |H|<0, the overall sign in 4.6.14 is positive.

The inequality 4.6.12, $(w_{wt}\, n\, \varphi - w_{ht-1}\, \beta) < 0$ is likely to occur when a net increase in Z_{ht-1} causes a net fall the wife's income (which is the reverse of the situation in 1 above). The conditions for which this inequality is likely to hold is when: her wage rate is low relative to w_{ht-1}; when the wage gap ($w_{ht-1} - w_{wt}$) is sufficiently large such that $(w_{wt}\, n\, \varphi - w_{ht-1}\, \beta) < 0$ holds; when φ is low, or when the proportion of transfers to his wife β is large.

In order to give an economic interpretation of the inequality 4.6.13, dividing both sides of 4.6.13 by a vector of prices of consumption goods, P_{wt} gives:

$$[U^{w}{}_{xx}\frac{w_{wt}(\psi - \varphi Z_{ht-1})}{P_{wt}}(w_{wt}n\varphi - w_{ht-1}\beta)] < P_{wt}\ \lambda_{w}\ w_{wt}\varphi \qquad (4.6.15)$$

As we saw in section 4.4, the marginal rate of substitution between the wife's demand for children (n) and demand for consumption goods (x_{wt}) from 4.12 is:

$$MRS^{w}{}_{n,\,x} = \frac{U^{w}{}_{n}}{U^{w}{}_{x}} = \frac{w_{wt}(\psi - \varphi Z_{ht-1})}{P_{wt}}$$

We already assumed that ($w_{wt}\ n\ \varphi$ - $w_{ht-1}\ \beta$) < 0 from 4.6.12. The conditions for which inequality 4.6.15 is likely to hold are when: the wife's real opportunity cost of childcare as a proportion of the prices of consumption goods, i.e. $w_{wt}\ (\psi - \varphi Z_{ht-1})/ P_{wt}$ is low; or when price of consumption (P_{wt}) is high (on the right hand side of 4.6.15) leading to low demand for x_{wt}. In this case, the demand for children as a proportion of the demand for consumption (x_{wt}) is high because the opportunity cost of childcare is lower relative to prices of consumption goods at a given income level.

We can call this an Unequal Power and Low Real Wage Rate scenario because this situation is likely to arise when the wife's wage rate is low relative to her husband's wage rate and when her opportunity cost of childcare $w_{wt}\ (\psi - \varphi Z_{ht-1})$ is low relatively to the price of consumption. In this scenario, a rise in Z_{ht-1} causes a net fall in the wife's income because an increase in income (for being able to work longer hours in paid work) is outweighed by the negative effect due to a reduction in the transfers from her husband. A net fall in the wife's income reduces her demand for children causing an income effect. However, since the wife's opportunity cost of housework $w_{wt}\ (\psi - \varphi Z_{ht-1})$ is low relative to prices, her demand for children is higher because she substitutes away from consumption towards wanting to have more children at a given income level, inducing a substitution effect. In this scenario, a rise in the husband's contribution causes the substitution effect to outweigh the income effect, and increases the wife's demand for children.

<u>Unequal Power and High Real Wage Rate Scenario</u>

$$If\ (w_{wt}\ n\ \varphi - w_{ht-1}\ \beta) < 0, \qquad (4.6.16)$$

$$\text{and } [U^{w}{}_{xx}\, w_{wt}(\psi - \varphi Z_{ht-1})\ (w_{wt}n\varphi - w_{ht-1}\beta)] > (P_{wt})^{2}\ \lambda_{w} w_{wt}\varphi \qquad (4.6.17)$$

Since $U^{w}_{xx} < 0$ and by assumption, ($w_{wt}\, n\, \varphi$ - $w_{ht-1}\, \beta$) < 0, both sides of 4.6.17 are positive. The economic interpretation of the inequalities is discussed shortly.

Then the following inequality holds:

$$\frac{\partial n}{\partial Z_{ht-1}} = \frac{1}{|H|}[U^{w}{}_{xx}\, w_{wt}\big(\psi - \varphi Z_{ht-1}\big)\, (w_{wt} n\varphi - w_{ht-1}\beta) - (P_{wt})^{2}\, \lambda_{w} w_{wt}\varphi] < 0 \qquad (4.6.18)$$

Because |H|<0, the overall sign in 4.6.18 is negative.

The conditions for 4.6.16 were discussed in 4.6.12 where the wife's wage rate is low relative to the husband's. The inequality sign of 4.6.17 is now the reverse of 4.6.15. In order to give an economic interpretation of 4.6.17, dividing both sides by P_{wt} yields:

$$[U^{w}{}_{xx}\frac{w_{wt}(\psi - \varphi Z_{ht-1})}{P_{wt}}\, (w_{wt} n\varphi - w_{ht-1}\beta)] > P_{wt}\, \lambda_{w}\, w_{wt}\varphi \qquad (4.6.19)$$

The conditions for which this could occur are when the opportunity cost of the childcare is high relative to prices (on the left hand side of 4.6.19) which causes the wife's relative demand for consumption to be high relative to her demand for children; or when the prices are low (on the right hand side of 4.6.19) so that the demand for consumption is high. We call this the Unequal Power and High Relative Wage-Price Scenario**.** A rise in the husband's contribution reduces the net income for the wife inducing an income effect, thereby reducing the demand for children. But a rise in the husband's contribution reduces the wife's opportunity cost of children and increases the demand for children substituting away from consumption causing a substitution effect. However, the substitution effect is not sufficient to outweigh the income effect causing an overall reduction in the demand for children. A summary of the three scenarios discussed above is given in Table 4.2.

If the wife's wage rate is relatively equal or high relative to the husband's (i.e. the Gender Equality Scenario), the prediction that a rise in the husband's contribution to housework increases the wife's demand for children makes sense. She does not want to have many children if her husband is not helpful because the opportunity cost of childcare is high. In the Unequal Power and Low Real Wage Rate scenario, even though a rise in the husband's contribution to housework reduces his wife's income (and reduce demand for children), because the prices of consumption goods are high relative to her opportunity

Table 4.2. Comparative Statics: Endogenous Intrahousehold Transfers

Exogenous change:		Possible scenarios	Impact on: Wife's demand for children (n)
A rise in Z_{ht-1}	1.	Gender Wage Equality Scenario	(+)
	2.	Unequal Power and Low Real Wage Rate Scenario (SE outweighs IE)	(+)
	3.	Unequal Power and High Real Wage Rate Scenario (IE outweighs SE)	(-)

Note: (+) denotes a positive effect and (-) denotes a negative effect. SE denotes a substitution effect and IE denotes an income effect.

cost of childcare, she substitutes away from consumption and desire more children. In the Unequal Power and High Real Wage rate scenario, a rise in the husband's housework induces an income effect from a decline in her income which is larger than an increase in the demand for children from a substitution effect leading to an overall decline in the wife's demand for children.

4.6.2 Stage One: Husband's Housework

Now turning to stage one, where the husband determines his time allocation. We substitute the intra-household transfers into the husband's budget constraint which yields:

$$P_{ht-1}\, x_{ht-1} - w_{ht-1}\,(T_h - Z_{ht-1}) + w_{ht-1}\,(T_h - Z_{ht-1})\beta \leq 0 \qquad (4.6.20)$$

Rearranging gives,

$$P_{ht-1}\, x_{ht-1} - w_{ht-1}\, T_h\,(1-\beta) + w_{ht-1}\, Z_{ht-1}(1-\beta) \leq 0 \qquad (4.6.20)$$

The lagrangian expression is now,

$$L_h = U^h(n(w_{wt}, \varphi Z_{ht-1}), x_{ht-1}) - \frac{1}{2}\alpha\,(|Z_{ht-1} - Z^e_{ht-1}|)^2 + \lambda_h\,[- P_{ht-1}\, x_{ht-1} + w_{ht-1}\, T_h\,(1-\beta) - w_{ht-1}\, Z_{ht-1}(1-\beta)] \quad (4.6.21)$$

Differentiating (4.6.21) with respect to x_{ht-1} , Z_{ht-1} and λ_h gives the following first order conditions,

$$U^h_x = \lambda_h\, P_{ht-1} \qquad (4.6.22)$$

$$U^h_n(\partial n / \partial Z_{ht-1}) = \alpha\,|Z_{ht-1} - Z^e_{ht-1}| + \lambda_h\, w_{ht-1} \qquad (4.6.23)$$

$$P_{ht-1}\, x_{ht-1} - w_{ht-1}\, T_h\,(1-\beta) + w_{ht-1}\, Z_{ht-1}(1-\beta) \leq 0 \qquad (4.6.24)$$

The endogenous transfers to his wife affect his budget constraint in 4.6.24.

When $\partial n / \partial Z_{ht-1} < 0$, (i.e the Unequal Power and High Real Wage Rate Scenario from the previous section), then the first order condition 4.6.23 cannot hold since there cannot be a negative amount of time.

In this case, the husband faces a corner solution and his time spent in housework is zero (i.e. $Z_{ht-1}= 0$) because he cannot spend a negative amount of time.

Assessing the Impact of a Rise in His Perception of Social Norms Z^e_{ht-1}

We now investigate the effect of a rise in Z^e_{ht-1} when the transfers to his wife are endogenous. As mentioned before, two individuals who have the same characteristics except for having different beliefs about men's responsibility in the housework would allocate different amounts of time to housework. Totally differentiating the first order conditions (4.6.22-24) with respect to Z^e_{ht-1}, where his choice variables are his consumption (x_{ht-1}), housework (Z_{ht-1}) and the lagrangian multiplier (λ_h), gives,

$$U^h_{xx}\frac{\partial X_{ht-1}}{\partial Z_{ht-1}{}^e} - \frac{\partial \lambda_h}{\partial Z_{ht-1}{}^e}P_{ht-1} = 0$$

$$U^h_{nn}\frac{\partial n}{\partial Z_{ht-1}}\frac{\partial Z_{ht-1}}{\partial Z_{ht-1}{}^e} + U^h_n\frac{\partial^2 n}{\partial Z_{ht-1}{}^2}\frac{\partial Z_{ht-1}}{\partial Z_{ht-1}{}^e} - \alpha\frac{\partial Z_{ht-1}}{\partial Z_{ht-1}{}^e} - \frac{\partial \lambda_h}{\partial Z_{ht-1}{}^e}w_{ht-1} = 0$$

$$(1-\beta)P_{ht-1}\left(\frac{\partial X_{ht-1}}{\partial Z_{ht-1}{}^e}\right) + (1-\beta)w_{ht-1}\frac{\partial Z_{ht-1}}{\partial Z_{ht-1}{}^e} = 0 \qquad (4.6.25)$$

Expressing these equations in matrix form yields:

$$\begin{bmatrix} U^h{}_{xx} & 0 & -P_{ht-1} \\ 0 & U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n\frac{\partial^2 n}{\partial Z_{ht-1}{}^2} - \alpha & -w_{ht-1} \\ (1-\beta)P_{ht-1} & (1-\beta)w_{ht-1} & 0 \end{bmatrix}\begin{bmatrix} \frac{\partial X_{ht-1}}{\partial Z_{ht-1}{}^e} \\ \frac{\partial Z_{ht-1}}{\partial Z_{ht-1}{}^e} \\ \frac{\partial \lambda_h}{\partial Z_{ht-1}{}^e} \end{bmatrix} = \begin{bmatrix} 0 \\ -\alpha \\ 0 \end{bmatrix} \qquad (4.6.26)$$

The Hessian determinant is given by,

$$|H| = U^h{}_{xx}w_{ht-1}{}^2(1-\beta) + P_{ht-1}{}^2\left(U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n\frac{\partial^2 n}{\partial Z_{ht-1}{}^2} - \alpha\right)(1-\beta) < 0 \qquad (4.6.27)$$

We know that $U^h{}_{xx} < 0, U^h{}_{nn} < 0$, and from 4.6.1, $(1-\beta) > 0$. If $\frac{\partial n}{\partial Z_{ht-1}} > 0$, from the quasi-concavity assumption of the total utility function in 4.22, namely:

$$\partial V_h{}^2/\partial Z_{ht-1}{}^2 = U^h_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h_n\frac{\partial^2 n}{\partial Z_{ht-1}{}^2} - \alpha < 0 \qquad (4.6.28)$$

Therefore the Hessian determinant is negative.[39]

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39. If $\frac{\partial n}{\partial Z_{ht-1}} > 0$, then both sides of the following inequality are positive: $U_{hn}\frac{\partial^2 n}{\partial Z_{ht-1}{}^2} < -U_{hnn}\frac{\partial n}{\partial Z_{ht-1}} + \alpha$.

Using Cramer's rule, the effect of a change in Z^e_{ht-1} on Z_{ht-1} is:

$$\frac{\partial Z_{ht-1}}{\partial Z_{ht-1}{}^e} = \frac{1}{|H|}\begin{bmatrix} U^h{}_{xx} & 0 & -P_{ht-1} \\ 0 & -\alpha & -w_{ht-1} \\ P_{ht-1} & 0 & 0 \end{bmatrix}$$

$$= \frac{1}{|H|}(-\alpha P_{ht-1}{}^2) > 0 \qquad (4.6.31)$$

If $\frac{\partial n}{\partial Z_{ht-1}} > 0$, the Hessian determinant is negative, therefore, $\frac{\partial Z_{ht-1}}{\partial Z_{ht-1}{}^e} > 0$. A rise in the perception on norms increases the husband's contribution to housework. However, if $\frac{\partial n}{\partial Z_{ht-1}} < 0$ (i.e. in the Unequal Power and High Wage-Price scenario) as discussed in the first order condition, the husband faces a corner solution and $Z_{ht-1} = 0$. In this case, $\frac{\partial Z_{ht-1}}{\partial Z_{ht-1}{}^e} = 0$.

The impact of a higher Z^e_{ht-1} on private consumption is shown by,

$$\frac{\partial X_{ht-1}}{\partial Z_{ht-1}{}^e} = \frac{1}{|H|}\begin{bmatrix} 0 & 0 & -P_{ht-1} \\ -\alpha & U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n\frac{\partial^2 n}{\partial Z_{ht-1}{}^2} - \alpha & -w_{ht-1} \\ 0 & w_{ht-1} & 0 \end{bmatrix}$$

$$= \frac{1}{|H|}\alpha w_{ht-1} P_{ht-1} < 0 \qquad (4.6.32)$$

If $\frac{\partial n}{\partial Z_{ht-1}} > 0$, the Hessian determinant is negative, so the overall effect is negative. A rise in Z^e_{ht-1} reduces the disutility for deviating from the norm. He substitutes away from consumption towards housework. These results show that the impact of a rise in Z^e_{ht-1} on the husband's time allocation and consumption decisions under endogenous transfers is the same as when the transfers are exogenous. However, if $\frac{\partial n}{\partial Z_{ht-1}} < 0$, there is no effect on private consumption from a rise in Z^e_{ht-1} .

<u>Assessing the Impact of a Change in Punishment from Deviating from Social Norms</u>

We look at the impact of a rise in α when transfers are endogenous by totally differentiating the first order conditions (4.6.22-24) with respect to α giving the following equations.

$$U^h{}_{xx}\frac{\partial X_{ht-1}}{\partial \alpha} - \frac{\partial \lambda_h}{\partial \alpha} P_{ht-1} = 0$$

$$U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}}\frac{\partial Z_{ht-1}}{\partial \alpha} + U^h{}_n\frac{\partial^2 n}{\partial Z_{ht-1}{}^2}\frac{\partial Z_{ht-1}}{\partial \alpha} - \alpha\frac{\partial Z_{ht-1}}{\partial \alpha} - \frac{\partial \lambda_h}{\partial \alpha}w_{ht-1} = |Z_{ht-1} - Z_{ht-1}{}^e|$$

$$P_{ht-1}\frac{\partial X_{ht-1}}{\partial \alpha} + w_{ht-1}\frac{\partial Z_{ht-1}}{\partial \alpha} = 0 \qquad (4.6.33)$$

This can be expressed in matrix form below,

$$\begin{bmatrix} U^h{}_{xx} & 0 & -P_{ht-1} \\ 0 & U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n\frac{\partial^2 n}{\partial Z_{ht-1}{}^2} - \alpha & -w_{ht-1} \\ P_{ht-1} & w_{ht-1} & 0 \end{bmatrix}\begin{bmatrix} \frac{\partial X_{ht-1}}{\partial \alpha} \\ \frac{\partial Z_{ht-1}}{\partial \alpha} \\ \frac{\partial \lambda_h}{\partial \alpha} \end{bmatrix} = \begin{bmatrix} 0 \\ |Z_{ht-1} - Z_{ht-1}{}^e| \\ 0 \end{bmatrix} \qquad (4.6.34)$$

The Hessian determinant is given by,

$$|H| = U^h{}_{xx}w_{ht-1}{}^2 + P_{ht-1}{}^2(U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n\frac{\partial^2 n}{\partial Z_{ht-1}{}^2} - \alpha) < 0 \qquad (4.6.35)$$

If $\frac{\partial n}{\partial Z_{ht-1}} > 0$, from 4.22,

$$U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n\frac{\partial^2 n}{\partial Z_{ht-1}{}^2} - \alpha < 0$$

And hence the Hessian determinant is negative.

The effect of a rise in the punishment for not conforming to social norms on the husband's time in housework (Z_{ht-1}) is shown by:

$$\frac{\partial Z_{ht-1}}{\partial \alpha} = \frac{1}{|H|}\begin{bmatrix} U^h{}_{xx} & 0 & -P_{ht-1} \\ 0 & |Z_{ht-1} - Z_{ht-1}{}^e| & -w_{ht-1} \\ P_{ht-1} & 0 & 0 \end{bmatrix}$$

$$= \frac{1}{|H|}(P_{ht-1}{}^2|Z_{ht-1} - Z_{ht-1}{}^e|) < 0 \qquad (4.6.36)$$

Since $\frac{\partial n}{\partial Z_{ht-1}} > 0$, the Hessian determinant is negative from 4.6.35, hence the overall effect is negative. A rise in punishment for not conforming to social norms (α) increases the disutility from doing so. Therefore, the husband reduces Z_{ht-1}. But if $\frac{\partial n}{\partial Z_{ht-1}} < 0$, $Z_{ht-1} = 0$. In this special case, there is no effect on Z_{ht-1} from a rise in α since he cannot reduce the amount of time any further than zero.

The effect on the husband's consumption (x_{ht-1}) is shown below.

$$\frac{\partial X_{ht-1}}{\partial \alpha} = \frac{1}{|H|}\begin{bmatrix} 0 & 0 & -P_{ht-1} \\ |Z_{ht-1} - Z_{ht-1}{}^e| & U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n\frac{\partial^2 n}{\partial Z_{ht-1}{}^2} - \alpha & -w_{ht-1} \\ 0 & w_{ht-1} & 0 \end{bmatrix}$$

$$= \frac{1}{|H|}(-w_{ht-1}P_{ht-1}|Z_{ht-1} - Z_{ht-1}{}^e|) > 0 \qquad (4.6.37)$$

The overall sign is positive because the Hessian determinant is negative. When the punishment for deviating from the norm is larger, there is a substitution away from allocating time in housework leading to a higher demand for consumption, as implied by the husband's marginal rate of substitution.

Again, $\frac{\partial n}{\partial Z_{ht-1}} < 0$, $Z_{ht-1} = 0$, and there is no effect on x_{ht-1} due to a rise in α.

The effect on the lagrangian multiplier is,

$$\frac{\partial \lambda_h}{\partial \alpha} = \frac{1}{|H|}\begin{bmatrix} U^h{}_{xx} & 0 & 0 \\ 0 & U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n\frac{\partial^2 n}{\partial Z_{ht-1}{}^2} - \alpha & |Z_{ht-1} - Z_{ht-1}{}^e| \\ P_{ht-1} & w_{ht-1} & 0 \end{bmatrix}$$

$$= \frac{1}{|H|}U^h{}_{xx}(-(|Z_{ht-1} - Z_{ht-1}{}^e|)w_{ht-1}) < 0 \quad (4.6.38)$$

Because $|H|<0$ and $U^h{}_{xx} < 0$, the overall sign is negative. This is not surprising since a rise in α reduces the husband's time allocated to housework and increases the time allocated to paid work. This increases his income, reducing the marginal utility of income.

Putting the together the results from Table 4.2 and the above outcomes on the husband's time in housework gives Table 4.3. A rise in the husband's perception of norms about men's housework ($Z^e{}_{ht-1}$) increases his allocation to housework in the Gender Equality and Unequal Power and Low Real Wage Rate scenarios. This, in turn, increases his wife's demand for children. Hence in these two scenarios, the implications of a rise in $Z^e{}_{ht-1}$ are the same as when the transfers to his wife were exogenous in sections 4.1-4.5. However, in the Unequal Power and High Real Wage Rate Scenario, a rise in $Z^e{}_{ht-1}$ has no effect on the husband's time allocated to housework, and subsequently has no effect on the wife's demand for children.

When the punishment for not conforming to social norms (α) is higher, the husband allocates less time to housework because of the disutility caused by doing so. In the Gender Equality and Unequal Power and Low Real Wage Rate scenarios, a fall in Z_{ht-1} reduces the wife's demand for children. But in the Unequal Power and High Real Wage Rate Scenario, a rise in α does not affect the husband's time in housework. This consequently has no impact on the wife's demand for children.

Therefore, we see that when the intra-household transfers are endogenous, the effects of exogenous changes in $Z^e{}_{ht-1}$ or α on the husband's time allocation and consumption decisions are the same as when the transfers were exogenous in the Gender Equality and Unequal Power and Lower Real Wage Rate scenarios. However, in the Unequal Power and High Real Wage Rate Scenario, exogenous changes in

Table 4.3. Comparative Statics under Endogenous Intrahousehold Transfers: Effect of a Rise in Perception of Norms, or a Rise in Punishment for Not Conforming to Norms

Exogenous change:	Possible Scenarios	Impact on first period's husband's time in housework (Z_{ht-1})	Impact on second period's wife's demand for children (n)
A rise in Z^{e}_{ht-1}	1. Gender Wage Equality Scenario	(+)	(+)
	2. Unequal Power and Low Real Wage Rate Scenario (SE outweighs IE)	(+)	(+)
	3. Unequal Power and High Real Wage Rate Scenario (IE outweighs SE)	(0)	(0)
A rise in α	1. Gender Equality Scenario	(-)	(-)
	2. Unequal Power and Low Real Wage Rate Scenario (SE outweighs IE)	(-)	(-)
	3. Unequal Power and High Real Wage Rate Scenario (IE outweighs SE)	(0)	(0)

Note: (+) denotes a positive effect, (-) denotes a negative effect, (0) denotes no effect. SE denotes a substitution effect and IE denotes an income effect.

Z^{e}_{ht-1} or α have no effect on the husband's time in housework because he faces a corner solution and he does not spend any time in housework at all (and therefore causing no effect on the wife's demand for children). The special case of the Unequal Power and High Relative Wage-Price scenario reverts to the existing fertility literature which assumes that the husband provides no contribution to housework such as those by Becker (1991), Hotz and Miller (1988) and Willis (1979).Therefore, the Stackelberg model with endogenous transfers developed in this section 4.6 is a general case fertility model in which the Becker-Hotz and Miller-Willis fertility model fits as a special case that occurs only under certain conditions outlined by the Unequal Power and High Real Wage Rate scenario.

CHAPTER 5

EMPIRICAL ANALYSIS

The Stackelberg model in the previous chapter developed the hypothesis that the higher the husband's time in housework in the first stage, the higher the wife's demand for children in the second stage. It is reasonable to assume that the wife's demand for children and her observed birth events are positively correlated, barring biological difficulties or her inability to be in charge of her reproductive rights. In this chapter, we develop the methodology to test the hypothesis that a woman whose husband allocates more time in housework is likely to face a higher birth probability. For brevity, we refer to the husband's time in housework and childcare as the husband's time in housework, or his contribution to housework.[40] We also present the data and the tests of selection bias and attrition.

The Stackelberg model also proposes that two distinct avenues exist through which attitudes and norms affect the husband's participation in housework, namely the formation of attitudes and values; and the social pressure to conform to these values and norms. The attitudes and values about gender roles in housework could be formed by the childhood environment, such as the region in which they grew up, because men's interpretation of gender assigned roles and norms on division of labor vary from region to region. Further, social pressure to conform to these norms is affected by the social environment in which the husband currently lives, either in a tight knit community or an urban setting where neighborhood interaction could be sparse (Fletschner and Carter 2008). The Stackelberg model predicts that the husbands who possess traditional attitudes towards housework are likely to spend less time in housework. It also predicts that men spend less time in housework if they live in tight-knit communities where the pressure to conform to social norms are high. In this chapter, we test whether men who grew up in regions known to be more traditional about gender roles spend less time in housework. Further, we test whether men who live

40. The time recorded in the data is an aggregate of time spent in housework and childcare.

in urban areas spend more time in housework because the neighborhood interaction is less and there could be less pressure to conform to gender norms.

In the previous chapter, we analyzed the case when the intra-household transfers from the husband to the wife are endogenous, namely that the transfers are a fixed proportion of the husband's income. However, we cannot empirically test the effect of change in the intra-household transfers on fertility because the data does not have information on the intra-household transfers. Therefore, testing the prediction of the model when the transfers are endogenous has to be left for future research.

We estimate birth probabilities using two approaches addressing two distinct questions. The first question asks, "Does the husband's time spent in housework increase the birth probability?", whereas the second question asks, "Does the husband's time in housework increase the time specific probability given that they did not have a birth until then?" The latter takes into account of spacing of births by estimating time specific birth probability, while the former ignores spacing. We examine these two questions because we are interested in finding out whether the husband's contribution to housework affects the birth probability, time specific birth probability, or both.

To address the first question, we ignore the spacing of births and use a pooled Instrumental Variable (IV) Probit model to estimate the husband's time in housework in the first stage and examine its effect on the probability of birth in the second stage. First, second and third births are estimated separately for each parity. To address the second question, we estimate the husband's time in housework taking into account the duration from the last birth in the first stage, and include the predicted value in the second stage. We measure the birth probability given that they did not have a birth until that particular point. A duration model is used in this approach.

There are three issues regarding the empirical approach that need to be mentioned. First, previous studies on fertility in developed countries have shown that factors affecting each parity are different, and therefore each parity is separately estimated (Hotz *et al* 1988, Newman and McCulloch 1984). We follow this approach in predicting birth probabilities for each parity. Given the increasing number of couples with one child, and the decreasing number of couples with three children in Japan, there are reasons to suspect that factors affecting each parity are different and therefore the above approach is appropriate (National Institute of Population and Social Security Research 2005).

Second, in order to examine the impact of the husband's time in housework on fertility, we will use an instrumental variable (IV) approach where the first stage is the log of the husband's time spent in housework and childcare and the second stage is to predict fertility. This is because we suspect that there are unobservable characteristics that affect both the husband's time spent in housework and his preferences for children. A person's willingness to do more housework, not captured by control variables, could affect the number of children he would like to have. For example, someone who helps out in domestic chores and childcare, all else equal, may also want to have more children. Alternatively, someone who spends a considerable time in housework may want fewer children because they want to spend more time with each child. Hence, the direction of the bias caused by the unobserved effects is not entirely clear. This implies that we cannot simply lag the time in housework and estimate its effect on fertility due to the presence of unobserved effects.

Third, similar to previous studies on fertility, our analysis only focuses on birth probabilities, and we do not explicitly consider the relationship between fertility decisions and women's labor supply (Heckman and Walker 1990, Newman and McCulloch 1984). Instead, variables that affect women's labor supply such as education and her prior work experience before marriage are included in the estimations.

In this chapter, the data and individual and household characteristics are discussed in sections 5.1 and 5.2, respectively. The empirical specification of the first approach using a pooled IV Probit model is discussed in section 5.3 and the second approach using a duration model is elaborated in section 5.4. In section 5.5, we discuss the two-step Maximum Likelihood Estimation (MLE) following Murphy and Topel's method (1985) to adjust the standard error terms for the duration model. In 5.6, we test for sample attrition and sample bias.

5.1 Data

The data is drawn from the *Japanese Panel Survey of Consumers* for 1993 to 2004 (12 waves) collected by the Institute for Research on Household Economics in Japan. The survey data collection methodology is as follows: (a) in 1993, 1,500 women ages 24 to 34 were randomly chosen and interviewed every October until 2004 (12 waves); and (b) in 1997, 500 women ages 20 to 29 were randomly selected and added to the sample, and interviewed every year until 2004 (7 waves), increasing the sample to 2000 women. A two stage sampling methodology is carried out where the first stage is to select the sampling area where regions in Japan are divided into eight, and the regions are further disaggregated into metropolitan cities, other cities and towns and villages. The number of primary survey units (i.e. women) to be selected from each sampling area is weighted according to the relative size of the population. In the second stage, the criteria of women to be sampled are distributed proportionally with the national average of age groups 24-34 for 1993 group and 20-29 for 1997 group, and their corresponding marital status. Women are then randomly selected in each sampling area according to these criteria.

The data includes socio-demographic and economic information of the household. If the respondent is married, socio-economic data on the husbands and their parents are collected. Detailed background information on the women and their husbands contains the prefecture where he grew up, whether they went to private school, whether they are first born daughters, or sons. It also includes the usual time the wife and husband spend on housework and childcare on a workday and a non-workday.

Figures 5.1 and 5.2 show the age-specific average number of children of married women from our data and national fertility surveys, respectively.

Taking into account that our data has only few observations of women ages 20-24 (n=441) and those over 45 (n=0), and that the frequency of the national fertility survey is only conducted every five years, when we compare the average number of children in the comparable time frame and age groups, the fertility rates between the two surveys are similar. Our data slightly underestimates the national average.

In this dissertation, in order to estimate the probability of observing each parity separately, we restrict our analysis to the sub-sample of women and their husbands who meet the following criteria: (1) women who were married the year the survey was conducted, indexed as *t*; (2) couples with no children at time *t* (designated as group A), only one child at *t* (group B), or only two children at *t* (group C) to estimate the probability of having the first, second and third child, respectively; (3) the husband’s time use on housework and childcare is recorded; and (4) the husband and wife’s family background is available. For groups B and C, the youngest child has to be at least one year old in order for the couple to physically face

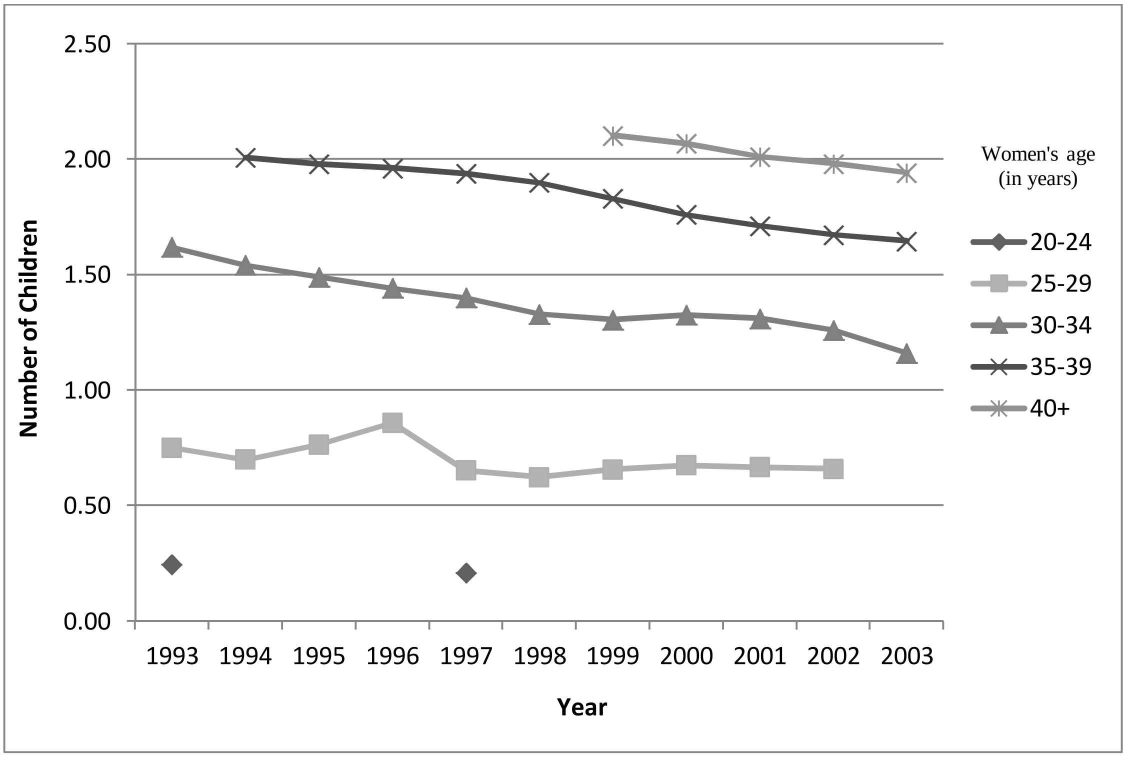

Figure 5.1. Average Number of Children by Married Women's Age Group 1993-2005 Using Our Data. *Note:* Japanese Panel Survey of Consumers 1993-2003, Based on the Author's Calculations.

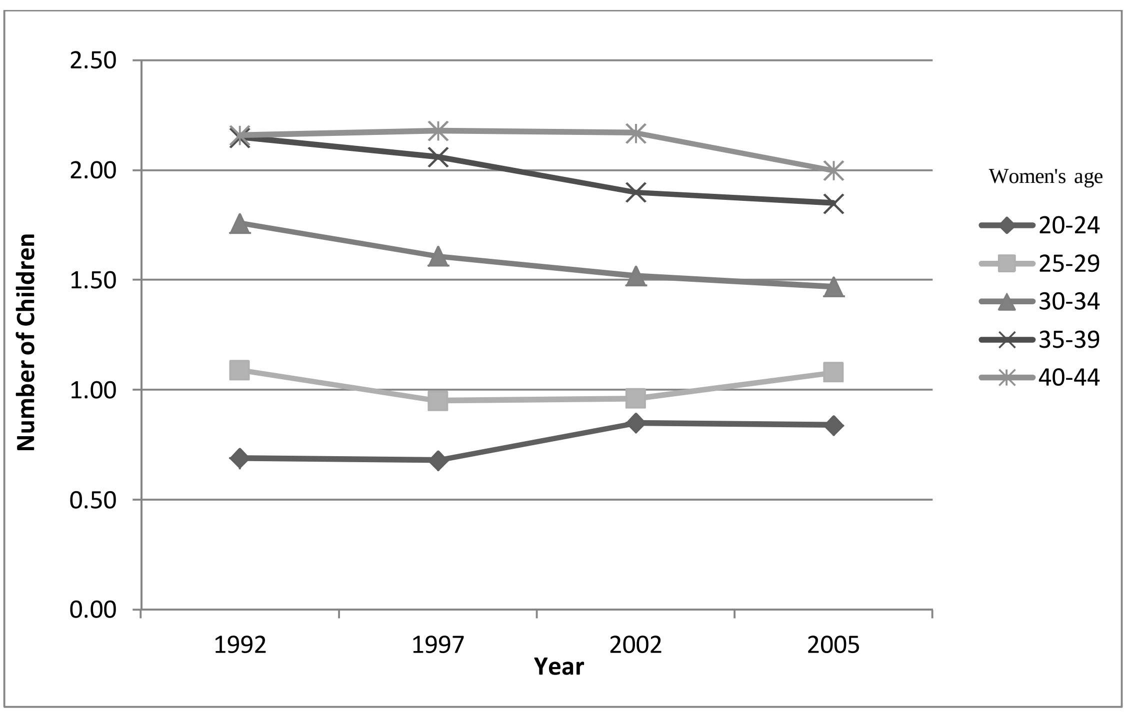

Figure 5.2. Average No. of Children by Married Women's Age Group 1992-2005 Using Japanese National Fertility Surveys. *Note:* Adapted from National Institute of Population and Social Security Research (2009).

the possibility of having another child. The births are recorded in yearly frequency so we cannot limit the birth intervals to 10 months. We test whether the way we grouped our sample causes a selection bias in section 5.3.

There are 184 households and 548 person-year observations in group A, 416 households and 1,381 person-year observations in group B and 580 households and 2,990 person-year observations in group C. We only include married women in the sub-sample because the proportion of non-marital births in Japan is low, representing 1.6 percent of all births in 2000 (National Institute of Population and Social Security Research 2003b).[41]

5.1.1 Baseline Statistics of Individual and Household Characteristics

Table 5.1.1 presents the baseline descriptive statistics of individual women and their husbands who fall in group A (no children), group B (only one child who is aged 1 or older) and group C (only two children and the youngest child is aged 1 or older) in the first year they are observed in the data. In other words, the descriptive statistics are not the pooled person year observations. During the sample, couples could transition into a higher parity group (e.g. from group A to group B) if they have a child. The baseline statistics show the first year they are observed in that particular group during the sample.

The average age of women in the first year they were observed in each group are 31.3 years (group A), 31.4 years (group B) and 32.7 years (group C), while the men's mean ages are 33.3 (A), 33.4 (B) and 35.3 (C). Age does not seem to vary by parity since the women in C are 1.4 years older than A and men in C are about 2 years older than A. The maximum age of women in the sample is 44 years old, hence all women are in their reproductive ages.

Group C women (24.7) married at an earlier age than those in A (27.3) and B (26.6). Further, women in group C had children at a younger age (26.4 years old) than women in B (28.9 years old).

The education variables are classified by their highest education attainment which are; (a) junior high school graduates; (b) senior high school graduates; (c) junior college graduates or technical school

41. In our data, only 0.15 percent of birth recorded in the last 12 months occurred to unmarried to women.

Table 5.1.1. Baseline Statistics of Individual and Household Characteristics, Mean Values Reported

	Wife			Husband		
	Group A $N = 184$	Group B $N = 416$	Group C $N = 580$	Group A $N = 184$	Group B $N = 416$	Group C $N = 580$
Individual Characteristics						
Age	31.3	31.4	32.7	33.3	33.4	35.3
Year born	1966.9	1966.0	1964.3	1964.8	1964.0	1961.7
Wife's age at marriage (in years)	27.3	26.6	24.7			
Wife's age at first birth (in years)		28.9	26.4			
Wife's years of work experience before marriage	1.9	3.1	3.7			
Highest Educational Attainment (percentage of total)						
A university graduate	21.2%	15.6%	10.9%	51.6%	43.5%	37.2%
A technical school or junior college graduate	47.3%	43.8%	37.6%	13.0%	14.9%	13.8%
A senior high school graduate	28.3%	38.2%	48.4%	33.7%	38.5%	44.1%
A junior school graduate	3.3%	2.4%	3.1%	1.6%	3.1%	4.8%
Family Wealth Proxy Variable (percentage of total)						
Went to a private senior high school, regardless of educational attainment	31.9%	30.8%	30.8%	25.9%	24.8%	24.8%
Spouse's Parents' Highest Educational Attainment (percentage of total)						
Father is a university graduate	25.5%	15.9%	10.2%	21.2%	17.8%	11.9%
Father is a technical school or junior college graduate	6.5%	5.6%	5.2%	1.6%	5.0%	3.6%

Table 5.1.1 continued.

	Wife			Husband		
	Group A N = 184	Group B N = 416	Group C N = 580	Group A N = 184	Group B N = 416	Group C N = 580
Wife's mother is a university graduate[a]	3.3%	2.2%	1.7%			
Wife's mother is a technical school or junior college graduate	9.8%	9.0%	6.6%			
Other Household Characteristics (percentage of total)						
Wife is 2 years or older than husband	8.2%	6.3%	2.8%			
Husband is 10 years or older than wife	3.8%	4.1%	2.9%			
Family Background						
Husband is a firstborn son				72.3%	70.0%	65.9%
Wife is a firstborn daughter	73.4%	69.2%	71.2%			
Number of siblings	1.4	1.4	1.5	1.5	1.6	1.6
Husband is a non firstborn son * number of siblings				0.48	0.6	0.7
Wife is a non-first born daughter * number of siblings	0.47	0.6	0.6			
Own mother was 25 or younger at his/her birth	29.3%	32.0%	34.8%	34.8%	37.3%	38.6%
Own mother was 26-30 at his/her birth	43.5%	46.2%	47.4%	45.1%	43.5%	41.1%
Own mother was 31 or older at his/her birth	27.2%	21.9%	17.8%	20.1%	19.2%	20.4%
Husband and wife's mothers were 31 or older at birth	3.3%	4.3%	4.5%			

Table 5.1.1 continued.

	Wife			Husband		
	Group A $N = 184$	Group B $N = 416$	Group C $N = 580$	Group A $N = 184$	Group B $N = 416$	Group C $N = 580$
<u>Region in which she or he grew up during primary and junior high school</u>						
Hokkaido	4.3%	4.3%	5.0%	7.1%	6.7%	5.5%
Touhoku	5.4%	8.4%	8.6%	3.8%	7.5%	8.8%
Kitakanto	5.4%	5.5%	5.3%	3.3%	4.6%	5.3%
Metropolitan Tokyo (Shutoken)	28.8%	28.1%	22.6%	28.3%	24.5%	20.2%
Metropolitan Osaka (Kansai)	17.9%	13.7%	13.1%	14.1%	13.7%	13.6%
Tokai	1.1%	2.6%	2.9%	3.8%	2.4%	2.4%
Chubu	21.2%	19.0%	20.5%	13.9%	19.7%	20.7%
Chugoku	5.6%	4.1%	8.6%	8.7%	8.3%	7.9%
Shikoku	2.7%	3.6%	4.1%	1.1%	3.8%	3.6%
Kyushuu	6.5%	9.6%	8.1%	10.3%	11.8%	10.7%
Okinawa	0.5%	1.0%	1.0%	0.5%	1.0%	0.9%
<u>Demographic variables</u>						
First child is a girl (Only for B)		42.4%				
First child is a girl * husband is firstborn son (Only for B)		29.6%				

[a] Husbands' mother's education is not tabulated in the table because it was not asked after the first year, therefore this information for newly wedded husbands is missing.

graduates (requiring high school diploma for entry); and (d) university graduates or more. Both women and men in A have a higher educational achievement than those in B and C, with group C having the lowest educational attainment. 21.2 percent of women in A have a university degree, whereas the respective percentages for B and C are 15.3 and 10.9 percent. Similar patterns are found for men with 51.6 percent in A having a university degree compared to 43.5 and 37.2 percent for B and C. A significantly larger proportion of women in C are at most junior or senior high school graduates (51.5 percent) compared to A (31.6 percent) and B (40.6 percent). The difference between groups A and C is therefore 20 percent. Similar differences are found for men, though in lesser magnitude with a difference of 12 percent between groups A and C.

A similar pattern emerges by looking at whether the women's father has a university degree. A large percentage of women in A have fathers who are university graduates (25.5 percent) compared to other two groups (15.9 percent for B and only 10.2 percent for C). Again, the difference of 15 percent between A and C is striking. However, the differences are relatively smaller between the three groups for the women's mothers and husbands' father education. Approximately 20 percent of husbands' fathers in A and B are graduates compared to 11.9 percent in C. Only about 2 percent of the women's mothers for B and C have a university degree, while the figure is 3.3 percent for A.[42] Mothers of women in A are slightly more likely to be a technical school or junior college graduate (9.8 percent) than those in C (6.6 percent). Therefore the greatest differences between the groups are found in the women's fathers' education and to a lesser degree in the husband's father's education, while little difference is found in the women's mothers' education.

Regardless of their education attainment, only a slightly higher percentage of women and men in A went to private senior high schools than those in C. The difference is only about 1 percent.

Women in A are slightly more likely to be a firstborn daughter (73.4 percent) than women in C (71.2 percent), and they have on average slightly fewer siblings (1.4) than C (1.5). Men in A are more likely to be firstborn sons (72.3 percent) than C (65.9 percent), and they have slightly fewer siblings (1.5)

42. The husband's mother's education was only asked in the first year, therefore information for those who married later in the sample is missing.

than C (1.6). It appears that women and men in A come from smaller families than those in C, although the difference in the number of siblings is small.

Approximately 20 percent of men for all groups have mothers who were 31 or older when they were born. A larger proportion of women's mothers in A were 31 or older (27.3 percent) than those in C (17.8 percent). Hence, women's mothers in C tended to have her daughter at a younger age than those in A. 3.2-4.5 percent of couples (for all groups) where both the husband and wife's mothers were 31 or older at their birth. There is little difference between the groups.

The largest percentage of women and men grew up in Metropolitan Tokyo or Metropolitan Osaka areas. A higher percent of women and men in A grew up in Metropolitan Tokyo (28.8 percent and 28.3 percent, respectively) than those in C (22.6 percent and 20.2 percent, respectively). We see a similar difference for women and men growing up in Metropolitan Osaka and for men in Chugoku. The difference between the regions is not significant between the groups, except for Touhoku (in the northern region) and Chubu for men (in central Japan). More women in B and C grew up in the Touhoku (8.4 percent and 8.6 percent, respectively) than A (5.4 percent). The difference among men is larger where only 3.8 percent of men in A grew up in Touhoku while the figure is 8.8 percent of men in C. A larger proportion of men in C grew up in Chubu (20.7 percent) than men in A (13.9 percent).

In summary, women and men with no children (A) tend to have a higher educational attainment and women have fathers with similar educational background. A higher proportion of them grew up in Metropolitan Tokyo or Osaka than other groups. Women with two children (C) married earlier and had their first child at an earlier age. A higher percentage of women and men in C grew up in areas outside of the two largest Metropolitan cities. However, there are relative small differences in their ages, the age of the husband's mother when the husband was born, or whether the woman or man went to a private senior high school. The descriptive statistics indicate some of the differences that we may see in estimating the birth probabilities.

5.1.2 Time Use

Time-use records of the husbands and wives allocated to market work, housework (including childcare), leisure and self-maintenance (such as sleep and eating) are included in the dataset. Time spent on housework and childcare is not asked separately, hence the aggregate amount of time for these activities is recorded. The questionnaire asks “what is the usual amount of time (in minutes) spent a day in a particular activity?” and is recorded separately for a workday and a non-workday.[43] The wife records the time-use information on behalf of her husband and therefore the men’s time allocation could be considered as the wives’ perception of their husband’s time. Therefore what we may be measuring is the perception of the husband’s contribution to housework by the wife, and one could argue that this is more important in their decision to have a child. For example, Sen (1990) argues that perceived contribution is more important than actual contribution, and one could therefore make the case that women’s perception of her husband’s input is a better measure of the wife’s level of satisfaction towards her husband’s contribution. If we expect that there is a measurement error in recording the husband’s time because she is doing this on his behalf, then it also strengthens our argument to use an IV approach.

The survey does not ask whether the woman is currently pregnant, but instead, asks whether they had a child in the last 12 months. We lag the husband’s time in housework twice in order to avoid the causality concerns that the husbands may have performed more housework because his wife is pregnant. We can express the causality of possible events, where *t-2*, *t-1* and *t* indicate the time the survey is administered (every 12 months) as below.

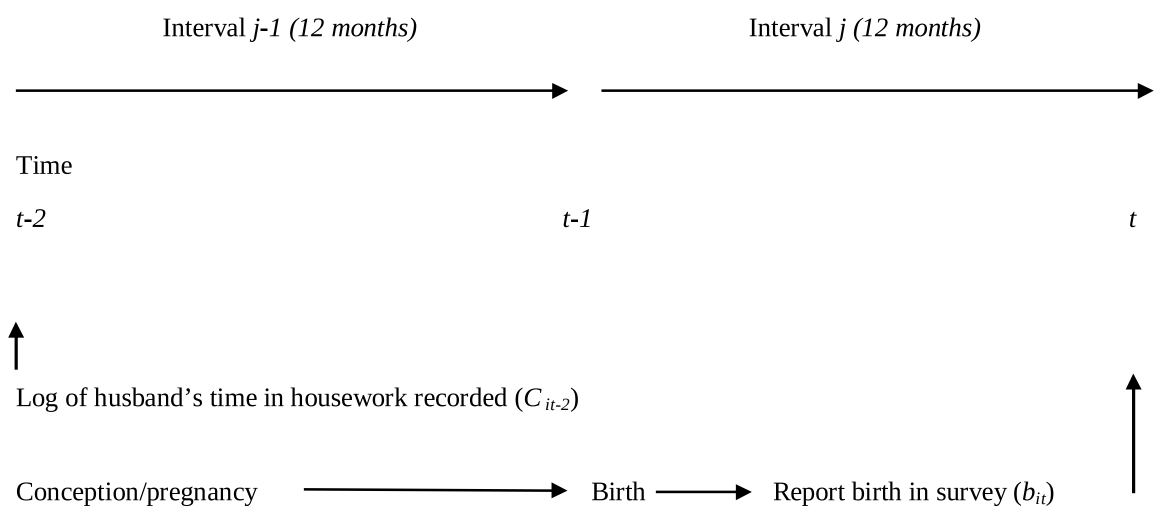

Figure 5.3. Causality of Possible Events from Conception to Birth.

43. Only the main activity is recorded, therefore activities that occur simultaneously are not recorded.

The husband's time allocated to housework recorded at *t-2* can affect fertility decisions between *t-2* and *t-1*. The wife will be pregnant for 10 months and the birth of a child occurs between *t-1* and *t*. The birth is only recorded at time *t* (b_{it}). Unfortunately, no information on contraceptive use is collected, therefore the only fertility information we observe is whether the couple had a birth in the last 12 months.

Table 5.1.2 shows the husband's average time in housework and childcare at *t-2* on a non-workday for the pooled person-year observations separately for groups A, B and C which are 49.4 minutes, 176.1 minutes and 173.8 minutes, respectively. In a given workday, the average time the husband spends in housework and childcare at *t-2* is much shorter at 12.5 minutes, 37.5 minutes and 36.0 minutes for A, B and C respectively. Therefore, the spike in the husband's time in housework occurs when the first child is born shown by the difference between groups A and B, but there is little difference between whether the couple has only one child (B) or two children (C).

The husband's time in housework and childcare on a non-workday at *t-2* is disaggregated by whether the couple had a child at *t*, and a t-test is used to assess whether there are statistical differences in the mean values for the pooled person-year observations (also in Table 5.2). The results reveal that for couples with one child (B), the husband's lagged time in housework at *t-2* that had a second child at *t* is about 27 minutes longer than those that did not have a second child and is significant at 5 percent. For couples with two children (C), the husband's time in housework at *t-2* that had a third child at *t* is about 17 minutes longer than those that did not have a child, but the difference is insignificant. For couples with no children (A) that had a first child at *t*, the mean time at *t-2* is actually 9 minutes shorter but the difference is statistically insignificant.

A similar test is conducted for a workday, and for all three groups, the husband's time in housework on a workday at *t-2* is longer when the couple had a child at *t*, but the difference is only significant for couples with one child (B). Therefore, we find that the husband's time in housework at *t-2* on a workday and non-workday is longer for couples that had a second child at *t*, but it is not statistically significant for couples that had their first, or third child. As discussed in Chapter 1, a separate panel survey conducted by the Ministry of Health, Labor and Welfare (2005) comes to the same conclusion; the husband's time spent in housework and childcare on a non-workday has a positive correlation with the

Table 5.1.2. Pooled Person-Year Observations Descriptive Statistics: Husband and Wife's Time Use in Paid Work[a] and Housework[b] at *t-2* (in Minutes per Day)

Husband	Obs	Mean	Had child at t	Did not have child at t	*t*-test[c]
		Group A			
Housework non workday	542	49.43	40.32	51.36	
Housework workday	542	12.47	14.95	11.95	
Paid work non workday	542	25.28	29.16	24.45	
Paid work workday	542	674.80	699.47	669.55	*
		Group B			
Housework non workday	1371	176.14	198.73	171.64	**
Housework workday	1371	37.53	47.41	35.56	***
Paid work non workday	1371	18.40	19.30	18.22	
Paid work workday	1371	677.77	669.04	679.51	
		Group C			
Housework non workday	2866	173.76	190.77	173.04	
Housework workday	2866	36.01	42.91	35.71	
Paid work non workday	2866	22.90	36.92	22.30	
Paid work workday	2866	676.80	667.52	677.20	

Wife	Obs	Mean	Had child at t	Did not have child at t	*t*-test[c]
		Group A			
Housework non workday	542	254.41	243.68	256.69	
Housework workday	542	213.36	218.63	212.24	
Paid work non workday	542	8.49	9.16	8.34	
Paid work workday	542	370.06	354.74	373.31	
		Group B			
Housework non workday	1371	474.36	533.03	462.66	***
Housework workday	1371	475.00	573.60	455.34	***
Paid work non workday	1371	4.52	3.86	4.65	
Paid work workday	1371	169.73	105.44	182.55	***
		Group C			
Housework non workday	2866	489.05	567.27	485.73	***
Housework workday	2866	463.77	573.60	455.34	***
Paid work non workday	2866	7.84	10.00	7.74	*
Paid work workday	2866	200.52	149.15	202.71	**

Note: Group A has no children, group B has one child who is one year or older and group C has two children and youngest is one year or older.

[a] Paid work includes time spent commuting.

[b] Housework includes time spent in childcare

[c] Test of equality of means of time spent in housework at *t-2* disaggregated by whether or not they had a child in the last 12 months at *t*.

*** significant at 1%, ** significant at 5 %, * significant at 10%.

likelihood of the couple having a second child, but it does not have a significant relation with the probability of having a first or third child. Therefore, our findings seem to be robust for different data sources.[44]

Among the wives in groups B and C, women who performed more housework on a workday and non-workday at *t-2* are more likely to have a child at *t*. For groups with no children (group A), the difference is not significant.

Time spent in paid work includes time spent in commuting. On average over three groups, men and women spend about 676 minutes (just over 11 hours) and 211 minutes, respectively on a workday in paid work and commuting. While these figures seem large especially for men, they are similar to the *2001 Time Use Survey* (Statistics Bureau 2001) which shows that, for example, men and women aged 30 to 39 in couple-only households with no children, which are comparable to our group A, spend 490 minutes and 218 minutes in paid work and commuting, respectively.[45] If we restrict the men in this group to only economically active men in the *2001 Time Use Survey*, then the figure is closer to ours at 650 minutes. Since almost all men in our sample are employed, the comparable group in the Time Use survey would be the economically active men.[46]

The *2001 Time Use Survey* shows that men and women aged 30 to 39 who live in couple households with children, which are comparable to our groups B and C, spend about 522 minutes and 144 minutes, respectively in paid work and commuting. For the economically active men in this group, the time

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44. The women and men surveyed in the Ministry of Health, Labor and Welfare (2005) questionnaire are slightly younger than our dataset.

45. Individuals in the 2001 Time Use Survey record their activities every 15 minutes for two days (Statistics Bureau 2001).

46. Men's participation in the labor force in our dataset, the *2001 Time Use Survey* and *2004 Labour Force Survey* (Statistics Bureau 2004) is similarly distributed and is around 95 percent between the ages 25 to 45. We would expect the time spent in paid work and commuting between all men and only economic active men to be similar in the *2001 Time Use Survey*. However, since this is not the case, it is not clear why there would a large difference.

spent is 649 minutes. Again, we see similar figures for time spent between all women and economically active men in the *Time Use Survey* and our groups B and C, which are 669.0 and 667.5 minutes, respectively.

The difference in the husband's time in paid work and commuting between groups A, B and C in our data is negligible. Disaggregating by whether or not the couple had a child within each group, for couples with no children (group A), the husband's work time at *t-2* is slightly longer for those that had a child at *t* than those that did not have a child and is marginally significant. Yet the difference in the husband's paid work time at *t-2* between those that had a second or third child is statistically insignificant. Hence, we find that while the husband's time spent in housework and childcare at *t-2* is significantly longer for couples that had a second child at *t* than those that did not have a child, the difference time spent in paid work is not significant.

In contrast, the wife's time in paid work is significantly different between those that had a child and those that did not have a child. Women who worked longer at *t-2* in groups B and C is less likely to have a child at *t*. Yet there is no difference for group A. This is consistent with women's labor participation rate that dips when the first child is born. Further, when we compare the women's time spent in paid work on a workday, the average time spent for C (200.5 minutes) is longer than B (169.8 minutes). This is likely to be explained by women leaving the workforce when their first child is born, but they reenter the labor force once their youngest child becomes older. As afore-mentioned, we take into account of the wife's labor force participation in our estimations by including variables that are likely to affect their labor supply, but we do not separately estimate labor supply.

5.1.3 Pooled Annual Income, Individual and Household Characteristics, and Demographic Variables

Table 5.1.3 shows the pooled person-year annual income, individual and household characteristics and demographic variables. The table provides information that could change from year to year, in contrast to time invariant variables that were discussed using the baseline characteristics in table 5.1.1. The first three rows show the annual labor income, government transfers (e.g., unemployment benefits, child allowance) and property income received by the wife and husband. All figures are reported in 1993 yen.

Table 5.1.3. Pooled Annual Income, Individual and Household Characteristics, and Demographic Variables, Mean Values Reported

	Wife			Husband		
	Group A *N* = 584	Group B *N* = 1,381	Group C *N* = 2,990	Group A *N* = 584	Group B *N* = 1,381	Group C *N* = 2,990
Annual Individual Income at t-2[a]						
Real labor income at *t-2*[b]	1,669,546.0	719,785.9	807,742.4	5,520,782.0	5,404,843.0	5,417,519.0
Real state transfers at *t-2*[c]	14,044	16,753	4,873	14,606.2	23,011.2	22,943.8
Real property income at *t-2*[d]	1,970	4,439	3,976	110,333.7	30,734.4	49,773.7
Household characteristics at t-2 (percentage of total)						
Lived with wife's mother at *t-2*	1.8%	5.5%	9.3%			
Lived with husband's mother at *t-2*	19.2%	20.6%	29.9%			
Lived in a metropolitan area at *t-2*	27.7%	23.7%	22.9%			
Demographic Variables (percentage of total)						
First baby born in last 12 months	17.5%					
Duration of marriage 0-4 years at *t*	47.1%					
Duration of marriage 5-8 years at *t*	25.6%					
Duration of marriage 9 + years at *t*	27.3%					
Second baby born in last 12 months		16.6%				
1 year since first birth at *t*		13.0%				
2-7 years since first birth at *t*		62.3%				
8 + years since first birth at *t*		24.7%				
Third baby born in last 12 months			4.2%			
1 year since second birth at *t*			9.0%			
2-7 years since second birth at *t*			51.5%			
8+ years since second birth at *t*			39.5%			

[a] Figures are expressed in 1993 yen.

[b] Labor income from salaries and self-employment.

[c] State transfers include child allowance and unemployment benefits. When the amount of the wife's state transfers is the same as the husband's state transfers, it is assumed to be the same source of income, and hence a value of zero is assigned to the wife's transfer amount.

[d] Property income includes income from physical property (rent), dividends and interest income. When the property income is the same for the husband and wife, it is assumed to be joint income, and hence a value of zero is assigned to the wife's property income.

Property income includes income from physical property (e.g. rent), dividend payments and interest income. Child allowance is most likely to be the major component of the government transfers. It is unlikely to be the unemployment benefits because 99.0% of husbands at *t-2* had jobs and 99.6% of them reported non-zero labor earnings at *t-2*.

Monthly child allowance is provided to low and middle-income families (National Institute of Population and Social Security Research 2003). As of 2007, for each child under the age of three, eligible households earning under a threshold income receive 10,000 yen a month (Ministry of Health, Labour and Welfare 2007b). Parents whose first and second child is between the ages of three and twelve, receive 5,000 yen a month, and for those whose third child or more children is between the ages of three and twelve receive 10,000 yen a month (Ministry of Health, Labour and Welfare 2007b). The primary earner in the household is the recipient of payment, which would usually be the husband (Ministry of Health, Labour and Welfare 2007b). In addition, local governments at city and ward levels provide additional support (in payments or health services) in accordance with their individual policies (Cabinet Office 2005). For example, the city of Funabashi in Chiba removed the income threshold required for child allowance and therefore all households, regardless of income, can receive the allowance (City of Funabashi 2009). Shinjuku city in Tokyo raised the eligible age requirements of the child to 15, so households with older children can still receive an allowance (Shinjuku City 2009).

Labor income, government transfers and property income are reported annually in the survey and separately for the husband and wife. When the values of the government transfers and property income reported by the husband and wife are equal, it is assumed that the source of income is the same and a value of zero is assigned to the wife's amount since child allowance is paid to the main earner who is likely to be the husband. When the wife's property income is the same as her husband's, we assume that income is derived from joint property and a value of zero is assigned to the wife.

The husband's real labor earnings are almost equivalent between the three groups. The husband's government transfers are greater for B and C than for A which is not surprising since it includes child allowance. There is almost no difference between B and C. Women in A earn the most labor income on average which was implied by the amount of time they spend in paid work in Table 5.2. Women in B earn the least, and less than women in C. This is likely to reflect the M shaped women's labor force participation (discussed in Chapter 1) where women leave the labor force during childbearing age, and rejoin the labor force once the youngest child is older. Women in group C are likely to be at a point where they rejoin the labor force. For 64% of women in C (shown in Table 4.3), it has been 8 years or more since the last birth, which is equivalent to the age of the youngest child.

A larger percentage of women in A had a job (full-time or part-time) at *t-2* than B or C. 71.2 percent of women at *t-2* had a job in A, which dips to 42.2 percent of women for B, and it increases slightly for C to 47.7 percent. These figures are similar to findings from other surveys that show that 67 percent of women were in the labor force before they had their first child, but 62 percent of these women leave the labor force after childbearing (National Institute of Population and Social Security Research 2005). The increase in percentage for C is likely to reflect the fact that some women may have returned to the labor force after the youngest child has grown older.

The percentage of women who had a job at *t-2* is disaggregated by educational attainment, and we find that among women in A (i.e. no children), a higher percentage of women who are university graduates had a job at *t-2* (75.8 percent) than other educational categories. Given that they are more likely to find better work opportunities, this is not surprising. However, among B, women who are university graduates were least likely to have a job at *t-2* with a figure of 38.6 percent. Women who are technical school or junior college graduates were also less likely to have a job at *t-2* (39.7 percent). In fact, women who are junior or senior high school graduates were more likely to have a job at *t-2* (46.1 percent) than any other educational categories in B. A similar pattern is observed for women in C. Women who are university graduates were less likely to have a job at *t-2* (44.4 percent) than junior or senior high school graduates (49.5 percent). Women who are technical college or junior college graduates also were less likely to have a job at *t-2* (46.0 percent). Therefore, what we observe is that when women do not have children, the more educated they are, the more likely they are to work. However, once the first child is born, more educated women are less likely to work. This is consistent with the survey result of Ministry of Health, Labour and Social Welfare (2006a) and Yamashita's study (1999) which were discussed in Chapter 1. Women who are more educated are less likely to rejoin the labor force once they had been out of the labor force after childbirth.

The percentage of couples who lived with the husband's mother at *t-2* significantly increases with parity. It increases from 19.6 percent (A), 20.6 percent (B) to 29.9 percent (C). There is almost no difference between A and B, but 10 percent more households in C lived with the husbands' mother than those in A. A similar pattern is observed for couples who lived with the wife's mother, though it increases at a smaller rate (1.8 percent for A, 5.5 percent for B, and 9.3 percent for C). This is likely to reflect the importance of having extra support in housework and childcare.

About a quarter of the sample for all groups lived in a metropolitan city at *t-2* with a slightly higher proportion for A.

We observe that 17.5 percent of those in A had the first child in the last 12 months, 16.6 percent had the second child for B, but only 4.2 percent had the third child for C. The low probability of observing the third birth reflects the fact that having a third child is a rare event.[47] For majority of B, it has been 1-7 years since the first child was born (75.3 percent), and for majority of those in C (51.5 percent), it has been 2-7 years since the second child was born. For this latter group, they are likely to have stopped having children at two children since it has been 8 years or more since the birth of the second child (39.5 percent). Almost half of A is in their first 4 years of marriage (47.1 percent).

5.2 Empirical Specification: First Approach Predicting Birth Using a Pooled IV Probit Model

In the first approach, we ignore birth spacing and only focus on whether the time spent in housework has an effect on fertility outcomes. We use a pooled IV Probit where the first stage is to estimate the log of the husband's time in housework for a couple *i* at *t-2* (C_{iht-2}) and the second stage is to examine its effects on the equation predicting fertility at *t*. As discussed earlier, an instrumental variable is used because there are possible unobserved differences that affect the husband's time in housework that could also affect his preferences for the number of children.

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47. Average number of children for married women born in the 1960s was 2.0 in the recent fertility survey (National Institute of Population and Social Security Research 2005).

The birth probability for each parity (i.e. separately for each group A, B and C) is estimated as follows.

$$b_{it}^* = W_{it\text{-}2}\,\theta_1 + C_{iht\text{-}2}\,\theta_2 + \gamma_t\,\theta_3 + u_{it} \quad (5.3.1)$$

Where b_{it}^* is a latent variable. A birth is observed in the last 12 months (y_{it} =1) if $b_{it}^*> 0$, and a birth is not observed ($y_{it} = 0$) if $b_{it}^* \leq 0$. $W_{it\text{-}2}$ is a vector of individual, household and background characteristics at *t-2*. γ_t is the yearly time specific effects common to all households represented by a dummy variable for each wave of the panel. $C_{iht\text{-}2}$ is the log of husband's time in housework on a non-workday at *t-2* (in minutes plus one minute) that we suspect is endogenous. Since the error term u_{it} is likely to be correlated for a household overtime, we allow for correlation of the errors by clustering the standard errors on the household. $\theta_{1,}$ θ_2 and θ_3 are coefficients to be estimated.

Exogenous variables in $W_{it\text{-}2}$ include individual and household characteristics (such as the education dummies, the year the wife was born, whether they live with the wife's or the husband's mother at *t-2,* wife's age at first birth, whether they live in a metropolitan city[48] at *t-2*, husband's gross annual labor earnings at *t-2,* husband's property income at *t-2,* husband's government transfers at *t-2* [49]); and family background variables (such as whether he went to a private senior high school, or the prefecture in which the husband grew up during primary and junior high school[50]). A variable in $W_{it\text{-}2}$ that affect fertility is the wife's age at first birth (included for B and C). This could measure the woman's fecundity where the woman may derive information about her own fecundity for the second or third births based her first birth experience (Heckman and Walker 1990b). It could also indicate her preferences for children. For A, since they do not yet have a child, the wife's age at marriage is included as a proxy for the wife's age at first birth. The two variables are highly correlated for B and C with a correlation coefficient of 0.83.

48. These are 13 metropolitan cities (Sapporo, Sendai, Chiba, Tokyo, Yokohama, Kawasaki, Nagoya, Kyoto, Osaka, Kobe, Hiroshima, Kitakyushu, Fukuoka) located across Japan and are not concentrated in a particular region.

49. Earnings are expressed in 1993 yen.

50. More precisely, it is the prefecture in which the husband spent the longest time during the nine years of primary and junior high school.

In Japanese families, it is customary for the firstborn sons to carry the family name, inherit the family property and care for the parents at an old age. Because men usually carry the family name, couples may be pressured to have a son. Hence, we interact the firstborn son variable with the dummy variable indicating that the first child is a girl (for group B). As discussed in chapter 1, there are regional differences in fertility rates and we take this into account by including dummy variables indicating the prefecture in which the husband spent the longest time during primary and junior high school. His childhood environment, represented by the region in which he grew up, is likely to affect his values and behavior towards fertility.

As discussed earlier, we do not specifically estimate the woman's labor force status in the fertility equation. Instead, we include factors that are likely to affect the woman's probability of joining the labor force. These include the year the woman was born, her education dummies, the number of years she worked prior to marriage and whether the couple lived with his or her mother at *t-2*. The number of years she worked prior to marriage is preferred over the number of years she worked (prior and during marriage) because it is a human capital stock she brought that is exogenous to decisions made within the marriage.

We estimate each parity and present the marginal effects in section 6.2. We test whether the coefficient θ_2 is positive for each parity. If it is positive, it confirms our hypothesis that women more helpful husbands face a higher birth probability.

The endogenous variable, the husband's time spent in housework (C_{iht-2}) is estimated as follows.[51]

$$C_{iht-2} = W_{it-2}\,\delta_1 + d_i\,\delta_2 + \gamma_t\,\delta_3 + \varepsilon_{it-2} \quad (5.3.2)$$

Where W_{it-2} and γ_t are already defined in 5.3.1. The vector d_i includes time invariant characteristics which are the instruments. The vectors δ_1, δ_2 and δ_3 are the coefficients to be estimated and ε_{it-2} is the error term. We assume that the error terms of 5.3.1 and 5.3.2 are jointly normally distributed, and we estimate equations 5.3.1 and 5.3.2 as a pooled IV Probit model using maximum likelihood (Cameron and Trivedi 2009). This allows for a correlation between the error terms u_{it} and ε_{it-2} which means that the shocks in *t-2* are correlated with the shocks in *t*. The wald test of exogeneity examines the hypothesis that there is no

51. More precisely, we take the log of the husband's time in minutes plus 1 minute.

correlation between u_{it} and ε_{it-2}. The standard errors are clustered by household by allowing for a correlation of the error terms to exist within each household.

In order to use Instrumental Variables (IVs), they have to satisfy two conditions: (1) they are correlated with the husband's time spent in housework; and (2) they are uncorrelated with the error terms of the main outcome variable of interest, namely the fertility outcome after controlling for the covariates (Wooldridge 2002). Hence, we have to find unobserved characteristics that are likely to affect the husband's time in housework, but not directly related to fertility.

The instruments we use are: (a) whether the husband's mother was ages 26 - 30 when he was born; and (b) the interaction terms between whether the husband's mother and wife's mother were 31 years old or older when they were born. The husbands' mothers' ages 26 - 30 at their birth represent 25 to 75 percentile of the cumulative distribution, and 31 years old and older represent 75 to 100 percentile of the cumulative distribution. The wives' mothers' ages at their births are also similarly distributed. The mother's age when the husband was born is about 27.1 years, and the figure is 27.4 year old for the wife.

Studies have shown that maternal age has an impact on their children's behavior. The effects of maternal age on their children's behavior are studied using a multivariate analysis in Australia (Shaw, Lawlor and Najman 2006) and New Zealand (Fergusson and Woodward 1999). Both find that younger maternal age at birth has a positive correlation with behavioral problems and poorer school performance in their adolescent or as young adult children. Turley (2003), on the other hand, argues that maternal age does not have a causal relation with their children's educational outcomes in the U.S. She finds that it is the woman's family background, not the maternal age that predicts her children's outcomes. She posits that women's socio-economic background, which correlates with the maternal age at birth, influences their children. Therefore, whether the maternal age has a causal impact on their children's behavior and outcomes are at best mixed in the child development and psychology literature. For our purposes, we are not concerned about the effect of maternal age on children's outcomes as long as these outcomes are observable and can be controlled for in our analysis. For example, to the extent that maternal age affects their children's educational achievement, we can control for this by including educational variables in the regression.

What we are interested in assessing is whether maternal age has an effect on their adult children's behavior towards housework and childcare. Fergusson and Woodward (1999) use a qualitative questionnaire to measure whether maternal age is correlated with their childrearing practices in New Zealand. They find that younger mothers are more likely to use harsher and more punitive childrearing practices such as physical punishment or being less emotionally responsive to their children. Older mothers are found to provide a more nurturing, stable and supportive home. In our analysis, we hypothesize that the maternal age of their birth, controlling for other factors, have shaped his or her attitudes and preferences towards housework and childcare. Children of older mothers may themselves provide a more supportive and nurturing home, leading to spending more time in housework and childcare. On the other hand, older mothers could also spoil their children

The two way scatter graph between the husband' time in housework at t-2 and the age of the husband's mother at his birth is shown in Figure 5.4.We see that the relationship between his time spent and his mother's age at birth is non-linear. Time spent in housework increases as the maternal age at birth increases but it falls if she was in her 30s at his birth.

In order to control for factors that could affect the maternal age at birth of the husband and wife in our study, we take into account that an older maternal age may be associated with: (a) the person having older siblings; (b) their parents have a higher educational achievement; and (c) the parents are wealthier. We control for the possibility that the husband has older siblings by creating a proxy variable for the birth order by interacting the dummy variable indicating that the husband is a non-firstborn son and the number of siblings he has. Similarly, a variable is created for the wife interacting a dummy variable that the wife is non-firstborn daughter and the number of siblings she has. Unfortunately, the data does not indicate the birth order of the husband or wife, only whether the husband is a firstborn son, or whether the daughter is a firstborn daughter. We include a dummy variable indicating that the husband's father has a university degree to control for the family background of the husband.[52] In order to capture wealth effects of their family, a dummy variable showing whether the husband went to a private senior high school is included.

52. The husband's mother's education was not collected every year so this is information is missing for husbands of newly wedded couples. The wife's parents' education is not included because they were found to be collinear with the wife's education.

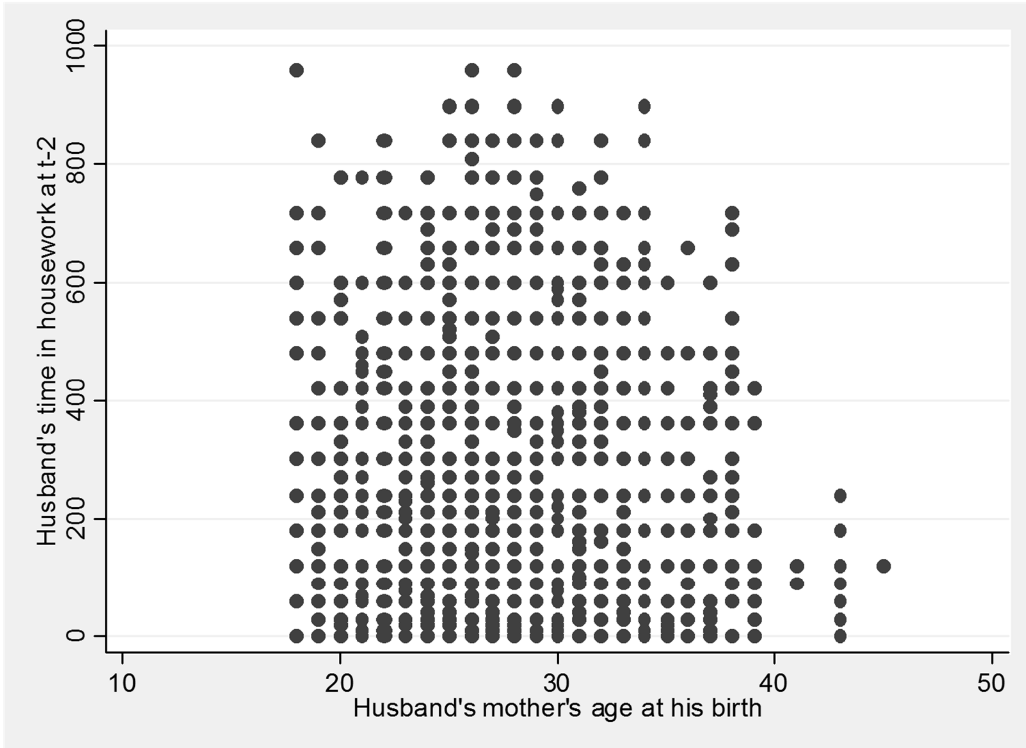

Figure 5.4. Plotting Husband's Time in Housework at T-2 (In Minutes) And the Age of the Husband's Mother at Birth. *Note*: Japanese Panel Survey of Consumers 1993-2003, Based on the Author's Calculations.

The latter two dummy variables intend to capture the socio-economic background of their families. Note that the binary variable indicating the husband went to a private senior high school is not a strong predictor of the husband's educational attainment.[53]

Studies in Japan have shown that mothers treat their son or daughter differently. Although the study does not control for the age of the mothers, Yamada (2004) finds that boys are given more leeway than girls in expanding their personal boundaries and asserting their wishes at an early age. For example, her results reveal that boys are more likely to be given permission to make decisions about food than girls. Japanese mothers also resolve conflicts by engaging in negotiations more often with their sons than with their daughters. Similarly, a study on Japan by Holloway and Behrens (2002) shows that Japanese women

53. The correlation coefficients between the private senior high school dummy variable and dummy variables for husband's highest education being a university graduate, technical school graduate, or high school graduate are less than 0.04 for the whole sample.

who were the firstborn daughters felt they had to grow up faster than their younger sibling. This may affect the likelihood of firstborn daughters to be more responsible towards housework and childcare chores. The interaction terms of the husband and the wife's mothers ages (31 years and older) are included to control for the possibility that maternal age could have a differential impact by the sex of the child, and this may affect the husband's willingness to perform housework. For example, an older mother may expect the daughter to help out in housework, but she may not have the same expectations towards a son.

Having controlled for family background and individual characteristics, we do not expect having an older mother to independently shape the number of children they prefer to have. The validity and relevance of these instruments in the estimations is discussed in section 6.1.1.

As discussed in the Stackelberg Fertility Model in Chapter 3, the prefecture the husband grew up is expected to affect his perception of norms towards gender roles in housework. For example, men in the southern island of Kyushu are considered to be male oriented and they would be less likely to spend time in housework. Generally, we expect men growing up in Tokyo and Osaka and their suburbs to contribute more to housework.

Couples living with a mother (of the husband or wife) could impact the husband's contribution to housework, where the mother substitutes work for either spouse, but we make no a priori assumption about whose work she substitutes. The year the wife is born is included to capture factors affected by the life cycle. The husband's year born is excluded because it is highly collinear with the year the wife is born.

Education can affect his contribution to housework in different ways. If the husband has more educational qualification such as a university degree, his time in housework could be higher than other men because he is more enlightened about an egalitarian division of labor. In time use studies in Israel, U.S. and Australia, it was found that more educated men spent more time in housework (Gronau 1977, Bianchi, Milkie, Sayer, and Robinson 2000, Floro and Miles 2003). Alternatively, it could reduce his share of housework because he spends more time in market work on a workday leading to a more specialized division of labor between the spouses, and which also affects his behavior on a non-work day (Becker 1991).

We also include two dummy variables to assess whether age differences affect their gender roles in the house: (a) the husband is 10 years or more older than his wife; and (b) the wife is 2 years or more older than her husband. There is a terminology for women who are in the (b) category and are called “anesan nyoubou” which means an older sister wife who are expected to have more power in the relationship than the husband. We expect the coefficient of the (a) to have a negative effect as husbands being much older to be more traditional and (b) to be positive.

5.3 Empirical Specification: Second Approach
Predicting the Timing of Birth
Using a Duration Model

In the second approach, we explicitly take into account of timing of birth by using a duration model. We want to estimate whether the husband’s time in housework affects birth timing. Duration models have been frequently used in previous studies to model fertility behavior (Blau and Robins 1989, Heckman, Hotz and Walker 1985, Heckman and Walker 1990, Merrigan and St.-Pierre 1998, Newman and McCulloch 1984, Todd, Winters and Stecklov 2008). These models measure the probability that a birth occurs at a specific instant given that it has not occurred up until that time. In our dataset, birth events that occurred in the twelve months prior to the survey are recorded in the same interval. The exact date of birth of the child is unknown, only the interval in which it occurred is recorded, known as interval censoring (Hosmer *et al* 2008). Due to the discrete nature of the dataset, which is recorded every 12 months, we use a discrete hazard model.[54] We refer to a “state” as the stages of fertility from the state of having no children to the state of having one child, and so on. Duration is defined as the time elapsed since the last birth.

However, we have to mention the restrictions that duration models face. Firstly, duration models assume that transitions into a state (e.g. having a second child) are independent of the transitions getting into the state in the first place (e.g. having the first child) (Hotz *et al* 1997, Jenkins 2004). In other words, it ignores the presence of unobserved heterogeneity that could have affected the transition into the state. Secondly, the explanatory variables in W_{it-2} have to be exogenous, and so we cannot perform any estimation with endogenous regressors (Jenkins 2004, Newman and McCulloch 1980). This means that an IV Probit

54. Note that hazard models and duration models are the same.

model discussed in 5.4, where we allowed for a correlation between the error terms of the first and second stages, is inappropriate in a duration model. Therefore in the empirical specification below, we have to assume that the error terms of the first and second equations are uncorrelated. In other words, the unobserved household characteristics or shocks in period *t-2* are assumed to be independent of those in period *t*. This may be a reasonable assumption since there are few events that could cause a shock to linger for two years. The only concern left is that there could be unobserved time invariant characteristics that are not captured by the control variables, which we try to address by using instrumental variables.

There are, however, advantages that duration models offer that are attractive for studying fertility. Duration models can estimate the birth probability in the presence of: (a) right censoring which refers to cases where individuals' transition to the next spell (i.e. having a birth) is not observed in the data, even though the spell is not completed (i.e. they did not yet have a child) (Hosmer *et al* 2008, Jenkins 2004); and (b) left censoring which occurs when the beginning of the spell (i.e. when a woman had a birth) is not observed in the data (Hosmer *et al* 2008, Jenkins 2004). In our dataset, we only observe women's fertility and time use at the point they enter and exit the sample. For example, in the first year the woman entered the sample, a respondent's first child could be aged two. We do not observe all the necessary information, such as her husband's contribution to housework, before she enters the sample. The justification for the use of a duration model to predict fertility in the presence of left and right censoring is provided in the Appendix D.

We now have to make assumptions about the functional form of the hazard function discussed in the Appendix D. We assume that the probability that a birth occurs in the interval *j* (defined as the period between *t-1* and *t*) given that it had not occurred at the end of the previous interval *j-1* (i.e. at *t-1*) for a couple *i* follows a logistic distribution as shown below (Hosmer and Lemeshow 2001).[55]

$$h_{ij} = \frac{exp(\beta_1' W_{it-2} + \beta_2' H_{it-2} + \beta_3' D(j) + \beta_4' \gamma_{t-j})}{1 + exp(\beta_1' W_{it-2} + \beta_2' H_{it-2} + \beta_3' D(j) + \beta_4' \gamma_{t-j})} \quad (5.4.1)$$

h_{ij} is measured by the probability that a couple has a child in the last 12 months given that they did not have a child until the end of the last interval *j-1*. The vector of individual, household and background

55. See figure 5.3 for graphical presentation of the causality from conception to birth.

characteristics at *t-2*, W_{it-2} and the yearly time specific effects, γ_t are defined in 5.3.1. *D(j)* is a vector of dummies indicating the time elapsed since last birth. H_{it-2} is the log of husband's time in housework on a non-workday at *t-2* that we suspect is endogenous. The sign and significance of the coefficient β_2 tests our hypothesis.

The endogenous variable, the husband's time in housework and childcare (in log of minutes plus 1 minute) for couple *i* at *t-2* (H_{it-2}) is estimated using a pooled linear equation (5.4.2).

$$H_{it-2} = W_{it-2}\,\eta_1 + D(j)\,\eta_2 + d_i\,\eta_3 + \gamma_t\,\eta_4 + \kappa_{it-2} \qquad (5.4.2)$$

Where the vector of individual, household and background characteristics at *t-2*, W_{it-2} and a vector of instruments, d_i and yearly time specific effects, γ_t are already defined in (5.3.1). *D(j)* is defined in 5.4.1. η_1, η_2, η_3 and η_4 are the coefficients to be estimated, and κ_{it-2} is the error term.

We use the predicted time in housework from the first stage in the second stage predicting fertility. However, we need to adjust the standard errors since we are using the estimated values of H_{it-2} (Greene 2003). We adopt two different methods for adjusting the standard errors in the second stage. In the first method, we use the bootstrap method and cluster the error terms by household, whereas in the second method, we use a two-step Maximum Likelihood Estimation using Murphy and Topel (1985) method which is discussed in sections 5.4 below.

5.4 Two-Step Maximum Likelihood Estimation (MLE) following Murphy and Topel's (1985) method

5.4.1 Formula for Covariance Matrix of the Murphy and Topel Two-Step MLE

Greene (2003: 511) shows that when there is an endogenous variable among the covariates in estimating the equation of interest, it is possible to use a two-step maximum likelihood procedure following Murphy and Topel's method (1985). While we can use the predicted value from the first stage in estimating the equation of interest in the second stage, we have to adjust the standard errors of the second stage. The standard errors of the second equation have to correct for the fact that the estimated coefficient of the endogenous variable is used in estimating the second equation.

In this section, we describe the two-step estimation procedure and the formula for the variance of the estimators in the second stage from Greene (2003: 508). For notational simplicity, let $\boldsymbol{H_i} = H_{it-2}$, $\boldsymbol{h_i}$ =

h_{ij} , $\boldsymbol{x}_i = [W_{it-2}, D(j), \gamma_t]$ and $\boldsymbol{z}_i = [W_{it-2}, D(j), \gamma_t, d_i]$ where $\boldsymbol{x}_i$ and $\boldsymbol{z}_i$ are the vectors of covariates. The vector $\boldsymbol{z}_i$ also contain the instruments d_i used for identification. We define the first and second stages as below.

- Stage 1: Husband's time spent in housework, $\boldsymbol{H}_i = E(\boldsymbol{H}_i \mid \boldsymbol{z}_i, \boldsymbol{\theta}_1)$
- Stage 2: The probability that a couple has a child in interval j given that the couple did not have a child at the end of the previous interval j-1 $= E(\boldsymbol{h}_i \mid \boldsymbol{x}_i, \boldsymbol{\theta}_2, E(\boldsymbol{H}_i \mid \boldsymbol{z}_i, \boldsymbol{\theta}_1))$

Where and $\boldsymbol{\theta}_1$ and $\boldsymbol{\theta}_2$ are vectors of parameters to be estimated. Greene (2003) shows that we can estimate $\boldsymbol{\theta}_1$ by maximizing the likelihood function in stage 1, which we call L_1, and include the predicted value of $\boldsymbol{\theta}_1$ in stage 2. $\boldsymbol{\theta}_2$ can be consistently estimated by maximizing the conditional likelihood function in model 2, namely L_2. However, the standard errors of the estimator $\boldsymbol{\theta}_2$ have to be adjusted to correct for the fact that a predicted value of $\boldsymbol{\theta}_1$ is used. The first and second stages could be estimated by maximum likelihood using a linear or non-linear models such as a linear regression, probit, logit or poisson models (Greene 2003).

Greene (2003: 510) provides the Murphy-Topel formula for the covariance matrix of $\boldsymbol{\theta}_2$ below:

$$V_2^* = 1/n\, [V_2+V_2\, (C\, V_1\, C' - R\, V_1\, C' - C\, V_1\, R')\, V_2] \qquad (5.5.1)$$

Where $\boldsymbol{V}_1$ and $\boldsymbol{V}_2$ are the covariance matrices of the first and second stage, respectively. $\boldsymbol{V}_2$ is estimated without correcting for the predicted value of $\boldsymbol{\theta}_1$ being used in the second stage. Note that the covariance matrix of $\boldsymbol{\theta}_1$, namely $\boldsymbol{V}_1$ does not have to be corrected. The covariance matrices $\boldsymbol{V}_1$ and $\boldsymbol{V}_2$ are derived below:

$$\hat{V}_1 = \left[\frac{1}{n}\sum_{i=1}^{n}\left(\frac{\partial lnL_{i1}}{\partial\hat{\boldsymbol{\theta}}_1}\right)\left(\frac{\partial lnL_{i1}}{\partial\hat{\boldsymbol{\theta}}_1'}\right)\right]^{-1}$$

$$\hat{V}_2 = \left[\frac{1}{n}\sum_{i=1}^{n}\left(\frac{\partial lnL_{i2}}{\partial\hat{\boldsymbol{\theta}}_2}\right)\left(\frac{\partial lnL_{i2}}{\partial\hat{\boldsymbol{\theta}}_2'}\right)\right]^{-1} \qquad (5.5.2)$$

The matrices C and R are estimated by (Greene 2003):

$$\hat{C} = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{\partial lnL_{i2}}{\partial\hat{\boldsymbol{\theta}}_2}\right)\left(\frac{\partial lnL_{i2}}{\partial\hat{\boldsymbol{\theta}}_1'}\right)$$

$$\hat{R} = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{\partial lnL_{i2}}{\partial\hat{\boldsymbol{\theta}}_2}\right)\left(\frac{\partial lnL_{i1}}{\partial\hat{\boldsymbol{\theta}}_1'}\right) \qquad (5.5.3)$$

Note that for the Murphy-Topel estimation, the clustering of standard errors by household is not available. Therefore, we have to assume that the error terms of the households, whose observations are repeated in the sample, are independent. This is likely to cause a downward bias in the standard errors because in the presence of a positive correlation between the independent variables overtime by a given household, the standard errors become larger (Cameron and Trivedi 2009). This is particularly true for time invariant variables where the correlation coefficient of these variables overtime by a household is one. Hence we expect the clustering of standard errors by household in the bootstrap method to be larger than the method using the Murphy-Topel method.

5.4.2 Our estimation Using the Murphy-Topel Two Step MLE

In Greene's (2003: 510) example, the first stage is a logit and the second stage is estimated as a poisson distribution. In our case elaborated below, we estimate the first stage as a linear regression, and the second as a logit model.

As mentioned above, $\boldsymbol{h_i}$ measures the probability that a couple has a child in the last 12 months given that the couple did not have a child at the end of the previous interval. We assume that this probability follows a logistic distribution where y_i measures the outcome (whether the couple has a birth or not in the last 12 months), and $\boldsymbol{x_i}$ is the vector of covariates that impacts on fertility decisions. The husband's time spent in housework $\boldsymbol{H_i}$ is likely to be endogenous and $\boldsymbol{z_i}$ is a vector that includes all variables in $\boldsymbol{x_i}$ and the instruments that identify the equation. The vectors of coefficients $\boldsymbol{\beta}$, $\boldsymbol{\gamma}$ are to be estimated.

$$h_i = prob(y_i = 1|z_i, x_i) = \frac{exp[\beta' x_i + \gamma E(H_i|z_i)]}{1 + exp[\beta' x_i + \gamma E(H_i|z_i)]} \quad (5.5.4)$$

For simplicity, following Greene's notations (2003: 511) by letting $\boldsymbol{x_i}$*= ($\boldsymbol{x_i}$, E($\boldsymbol{H_i}$ | $\boldsymbol{z_i}$))' and $\boldsymbol{\theta_2}$ = ($\boldsymbol{\beta}$, $\boldsymbol{\gamma}$)', (5.5.4) can be express as:

$$h_i = prob(y_i = 1|z_i, x_i) = \frac{exp(x_i^{*\prime}\boldsymbol{\theta_2})}{1 + exp(x_i^{*\prime}\boldsymbol{\theta_2})} \quad (5.5.4)$$

Assuming that n is the number of household-year observations, the log-likelihood function for the second stage given in equation (A9) in the Appendix D becomes:[56]

$$lnL_2 = \sum_{i=1}^{n} [y_i ln h_i + (1 - y_i) ln(1 - h_i)] \quad (5.5.5)$$

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56. In Appendix D, n is the number of households and k indexes the intervals (represented by years) observed in the data.

Following Greene (2003), substituting (5.5.4)' into (5.5.5) and rearranging, the log likelihood can be expressed as,

$$lnL_2 \;=\; \sum_{i=1}^{n}\left[y_i x_i^{*\prime}\boldsymbol{\theta_2} - \ln\left(1+\exp\left(x_i^{*\prime}\boldsymbol{\theta_2}\right)\right) + (1-y_i)\ln\left(1-\frac{\exp(x_i^{*\prime}\boldsymbol{\theta_2})}{1+\exp(x_i^{*\prime}\boldsymbol{\theta_2})}\right)\right] \qquad (5.5.6)$$

For stage 1, the husband's time spent in housework $\boldsymbol{H_i}$ is estimated as a linear regression model equation where θ_1 is a vector of parameters to be estimated by maximum likelihood and $\boldsymbol{u_i}$ is the residuals.

$$\boldsymbol{H_i} = \boldsymbol{z_i}'\,\theta_1 + \boldsymbol{u_i} \qquad (5.5.7)$$

We assume that the likelihood function for stage 1 follows a normal distribution as given in Greene (2003:492).

$$L_1 = \prod_i^n (2\pi\sigma^2)^{-1/2} exp\left(-\frac{(H_i - z_i\boldsymbol{\theta_1})^2}{2\sigma^2}\right) \qquad (5.5.8)$$

Where σ^2 is the variance of the population and π is a constant.

Taking the logarithm of (5.5.8) gives:

$$lnL_1 = ln\left[(2\pi\sigma^2)^{-n/2}\, exp\left(-\frac{(H_i - z_i\boldsymbol{\theta_1})^2}{2\sigma^2}\right)\right] \;=\; -\frac{n}{2}ln2\pi - \frac{n}{2}ln\sigma^2 - \sum_{i=1}^{n}\left(\frac{(H_i - z_i\boldsymbol{\theta_1})^2}{2\sigma^2}\right) \qquad (5.5.9)$$

In order to construct the covariance matrices for the Murphy Topel estimator, we have to find the derivative of the log-likelihood functions with respect to $\boldsymbol{\theta_1}$ and $\boldsymbol{\theta_2}$, respectively.

The derivative of (5.5.9) with respect to $\boldsymbol{\theta_1}$ is:

$$\frac{\partial lnL_1}{\partial\boldsymbol{\theta_1}} = \sum_{i=1}^{n}\left(\frac{2z_i'(H_i - z_i\boldsymbol{\theta_1})}{2\sigma^2}\right) = \sum_{i=1}^{n}\left(\frac{z_i'(H_i - z_i\boldsymbol{\theta_1})}{\sigma^2}\right) \;=\; \sum_{i=1}^{n}\left(\frac{z_i' u_i}{\sigma^2}\right) \qquad (5.5.10)$$

The derivative of (5.5.6) with respect to $\boldsymbol{\theta_2}$ is:

$$\frac{\partial lnL_2}{\partial\boldsymbol{\theta_2}} \;=\; \sum_{i=1}^{n}\left[y_i[x_i^{*\prime} - \frac{exp(x_i^{*\prime}\boldsymbol{\theta_2})x_i^*}{1+exp(x_i^{*\prime}\boldsymbol{\theta_2})}] + (1-y_i)\left(1-\frac{exp(x_i^{*\prime}\boldsymbol{\theta_2})x_i^*}{1+exp(x_i^{*\prime}\boldsymbol{\theta_2})}\right)\right] \;=\; \sum_{i=1}^{n} x_i^*\left[y_i - \frac{exp(x_i^{*\prime}\boldsymbol{\theta_2})}{1+exp(x_i^{*\prime}\boldsymbol{\theta_2})}\right] =$$

$$\sum_{i=1}^{n}[y_i - h_i]x_i^* \;=\; \sum_{i=1}^{n} v_i x_i^* \qquad (5.5.11)$$

Where we define $v_i = y_i - h_i$.

The derivative of (5.5.6) with respect to $\boldsymbol{\theta_1}$ is:

$$\frac{\partial lnL_2}{\partial\boldsymbol{\theta_1}} \;=\; \sum_{i=1}^{n}\left[y_i[\gamma z_i - \frac{\gamma exp(x_i^{*\prime}\boldsymbol{\theta_2})z_i}{1+exp(x_i^{*\prime}\boldsymbol{\theta_2})}] + (1-y_i)\left(1-\frac{\gamma exp(x_i^{*\prime}\boldsymbol{\theta_2})z_i}{1+exp(x_i^{*\prime}\boldsymbol{\theta_2})}\right)\right] \;=\; \sum_{i=1}^{n}\gamma z_i\left(y_i - \frac{exp(x_i^{*\prime}\boldsymbol{\theta_2})}{1+exp(x_i^{*\prime}\boldsymbol{\theta_2})}\right) \;=$$

$$\sum_{i=1}^{n}\gamma v_i z_i \qquad (5.5.12)$$

Substituting (5.5.10) into (5.5.2) gives the covariance matrix for $\boldsymbol{V_1}$:

$$\hat{V}_1 = \left[\frac{1}{n}\sum_{i=1}^{n}\left(\frac{z'u_i}{\sigma^2}\right)\left(\frac{z'u_i}{\sigma^2}\right)\right]^{-1} = \left[\frac{1}{n}\sum_{i=1}^{n}\left(\frac{z'z}{\sigma^2}\right)\left(\frac{u_i'u_i}{\sigma^2}\right)\right]^{-1} \quad (5.5.13)$$

Where **z** is a vector of covariates.

Greene (2003: 493) shows that the variance estimator for a maximum likelihood estimation of a normal linear regression is:

$$\hat{\sigma}^2{}_{ML} = \frac{1}{n}\sum_{i=1}^{n}(u_i'u_i) \quad (5.5.13)$$

Substituting this into (5.5.13) gives the estimated covariance matrix for $\boldsymbol{V_1}$ yields:

$$\hat{V}_1 = \left[\sum_{i=1}^{n}\left(\frac{z'z}{\sigma^2}\right)\right]^{-1} \quad (5.5.14)$$

We obtain the covariance matrix of $\boldsymbol{V_2}$ by substituting (5.5.11) into (5.5.2):

$$\hat{V}_2 = \left[\frac{1}{n}\sum_{i=1}^{n} v_i^2 x_i^{*\prime} x_i^*\right]^{-1} \quad (5.5.15)$$

Substituting into (5.5.10), (5.5.11) and (5.5.12) into (5.5.3) gives the estimators for matrices *C* and *R*:

$$\hat{C} = \frac{1}{n}\sum_{i=1}^{n}(v_i x_i^*)(\gamma v_i z_i) = \frac{1}{n}\gamma\sum_{i=1}^{n} v_i^2 x_i^* z_i'$$

$$\hat{R} = \frac{1}{n}\sum_{i=1}^{n}(v_i x_i^*)\left(\frac{z'u_i}{\sigma^2}\right) = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{v_i u_i x_i^* z'}{\sigma^2}\right) \quad (5.5.16)$$

By substituting (5.5.14), (5.5.15) and (5.5.16) into the Murphy-Topel formula given in (5.5.1) gives the covariance matrix of the parameters $\boldsymbol{\theta_2}$ of the second stage logit model.

5.4.3 Variance of the Marginal Effects

Since we are interested in estimating the marginal effects of the covariates predicting the birth probabilities, it requires an extra step to calculate the standard errors of the marginal effects. The probability distribution follows a logistic cumulative distribution function,

$$G(x_i^*) = prob(y_i = 1|x^*) = \frac{exp(x_i^{*\prime}\boldsymbol{\theta_2})}{1+exp(x_i^{*\prime}\boldsymbol{\theta_2})} \quad (5.5.16)$$

Where $\boldsymbol{x}^*$ and $\boldsymbol{\theta_2}$ were defined earlier.

Greene (2003: 674) shows that the asymptotic variance of the marginal effects of a logit model can be estimated by:

$$Asy.Var(\hat{\pi}) = [\hat{G}(1-\hat{G})]^2 V\left[I + (1-2\hat{G})x_i^*\boldsymbol{\theta}_2'\right] \quad (5.5.17)$$

Where $\hat{\pi}$ is the estimated marginal effects, $\hat{G}$ is the predicted probabilities derived by inserting the predicted coefficients of $\boldsymbol{\theta_2}$ into (5.5.16), and $\boldsymbol{I}$ is a k x k identity matrix where k is the number of covariates plus one for a constant. $\boldsymbol{V}$ is the estimated covariance matrix of $\boldsymbol{\theta_2}$ and in our case, we use the Murphy-Topel covariance matrix derived in (5.5.1).

Note that the values of the marginal effects $(\hat{\pi})$ do not require a correction for a two-stage estimation because it is independent of the standard errors of the first stage in the estimations. Therefore the marginal effects for the bootstrap method will be the same as the marginal effects using the Murphy-Topel standard errors.

5.5 Testing for Sample Selection Bias and Attrition Bias

Before we present the results of our estimations in chapter 5, we test the presence of sample selection bias and attrition bias. There are two different sources of potential biases which require further examination. Firstly, the way we restricted the sample to group A, B and C may have created a sample selection bias where unobservable characteristics that affect sample selection could also be related to the unobservable characteristics that predict the outcome of interest. Secondly, we have to examine whether attrition from the sample creates an attrition bias. The attrition rates for the cohort that joined in 1993 after twelve waves (including unmarried women) is about 37.0 percent, and for the cohort that joined in 1997 after seven waves is about 37.6 percent.

Three tests were conducted to check: (1) if the criteria used in creating the sub-sample for this study creates a sample selection bias; (2) whether there is an attrition bias; and (3) whether attrition creates attrition biases on observable characteristics. Tests were conducted using Wooldridge (2004) for (1) and for one of the two tests of (2), and Fitzgerald, Gottschalk and Moffitt (1998) for the other tests of (2) and for (3).

5.5.1 Testing for Sample Selection

The sample selection test is used to examine whether unobservable characteristics of being in the sample are correlated with the unobservables of the equation of interest (Wooldridge 2004: 552). This is the Heckman's sample selection bias problem extended to panel data to test whether the way we restricted the sub-sample in section 5.1 biases our estimates. Using all women and years observed in the sample, we create a selection variable r_i which is equal to one if the observation is in group A, and zero otherwise. Following Wooldridge's procedure (2004: 582), we run a two-step Heckman selection model where the first stage is to predict selection r_i on the woman's characteristics using a pooled probit, and the second stage is to estimate the log of the husband's time in housework on a non-workday at *t-2*. The inverse mills ratio (IMR) derived from the first stage selection probit is included in the second stage and tested for its significance. If the inverse mills ratio is significant, then we cannot reject the hypothesis that there is no selection bias. We also conduct the same test for groups B and C. We test this using all women person-year observations in the sample with the exception for wave three.[57]

The real value of physical assets given from the woman's parents to the woman (or couple if married) while they are alive by *t-2* and the physical and financial assets ever inherited from the woman's parents to the woman (or couple if married) by *t-2* are used as instruments to identify the equation.[58] The instruments have to be related to the whether an individual is in groups A, B or C (which is the first stage), but unrelated to the error terms of the second equation estimating the husband's time in housework after controlling for other factors (Wooldridge 2002). Physical and financial assets transferred from the parents by inheritance or given can be considered to be exogenous shocks since they are not likely to be affected by an individual's actions or behavior. The assets represent an exogenous increase in wealth that is likely to affect one's decisions to form a family, possibly giving greater incentives to have children. Alternatively, there could be an inverse relationship between wealth and fertility as observed in developed countries

57. The question "what is the value of the physical assets given by parents when alive?" was asked in waves 2, 5, 6, 8, 10, 11 and 12. Since we do not have information for wave 1, when we lag this variable by two years, we do not have the lagged value in year 3. Hence, the number of observations is slightly smaller than the size of the groups A, B and C since we miss the observations in wave 3. For missing years after wave 3, assume that once a value is recorded, it is the same in subsequent years unless other values are recorded. If a value of zero is recorded, we assume that the values are zero in the prior years.

58. The question "what is the value of the inheritance you ever received from your parents?" was asked in waves 2, 5, 6, 8, 10, 11 and 12. For the missing waves 3, 4, 7 and 9, a question was asked "what was the value of the inheritance received in the last 12 months?" and hence the sum of the value of the inheritance received in the last 12 months if her parent passed away and the value of the inheritance ever received by the prior year is used for waves 3, 4, 7 and 9.

(Becker 1991, Hotz *et al* 1997). This in turn affects their probabilities of being in groups A, B or C. But they do not independently affect the husband's time in housework after controlling for other variables.

The independent variables used are based on the women's characteristics since the husbands' characteristics are missing if they are unmarried. Assets inherited or given by the parents could be affected by the family's wealth and her family composition. Hence, to proxy for family wealth, we include her father's education dummies, whether she went to a private high school and the prefecture in which she grew up. In order to control for family composition that could affect inheritance or gifts, we include an interaction term between whether she is a non-firstborn daughter and the number of siblings she has. This is a proxy for the birth order since this is not directly asked in the survey. Family wealth, family composition and regional information also affect the differences in values and attitudes towards family formation and intra-household division of labor developed by being raised in different regions and the family environment, hence are included in both the first and second stage estimations.

The husband's time in housework on a non-workday is likely to be affected by the woman's probability of joining the labor force. As covariates, we include the year the woman was born, her education dummies, the number of years she worked prior to marriage for married women, and the number of years she worked if unmarried and whether she lived with her mother at *t-2*. The year born also affects the woman's life cycle such as having children.

We do not expect assets inherited or given by the parents to independently impact the husband's time spent in housework after controlling for wealth, family background and composition and individual characteristics.

The pooled two-stage Heckman using all person-year observations are given in Table 5.5.1.

The value of the physical assets given by the woman's parents by *t-2* has a negative effect on the probability of being in A (i.e. no children). The value of the assets inherited by the woman's parents by *t-2* has a positive effect on the probability of being in B (with one child), but has a negative effect of being in C (with two children). This suggests that the relation between fertility and assets inherited or transferred, which is a wealth effect, could be non-linear. Those with wealth could have one child, but they could stop childbearing with fewer children as observed in developed countries. The coefficient on the inverse mills ratio in the second stage for all three groups is not significant indicating that there is little evidence of sample selection bias.

5.5.2 Testing for Attrition Bias

Here, we use two tests to investigate the presence of attrition bias, one by Wooldridge (2004) and one by Fitzgerald *et al* (1998).

In the first test, we examine the presence of attrition bias by testing whether sample attrition is a significant predictor in the estimations, following the procedures outlined by Wooldridge (2004; 581). This examines whether attrition is correlated with the error terms of the equations we are estimating. An attrition

5.5.1. Testing for Sample Selection Based on Women's Characteristics

	First stage	Second stage	First stage	Second stage	First stage	Second stage
Dependent variable	$r_i = 1$ if in group A, $r_i = 0$ otherwise	Log of husband's time in housework at t-2	$r_i = 1$ if in group B, $r_i = 0$ otherwise	Log of husband's time in housework at t-2	$r_i = 1$ if in group C, $r_i = 0$ otherwise	Log of husband's time in housework at t-2
Instruments						
Log of value of physical and financial assets ever inherited from woman's parents by *t-2*[a]	-0.0119 (0.0122)		0.0159** (0.00709)		-0.0178*** (0.00658)	
Log of value of physical assets ever given by woman's parents by *t-2*[a]	-0.0459** (0.0209)		0.0134 (0.00846)		-0.00385 (0.00760)	
Inverse Mills ratio		-2.844 (2.513)		3.188 (1.967)		0.157 (1.417)
Woman's characteristics						
Year born	0.0205*** (0.00664)	-0.0383 (0.0581)	0.0204*** (0.00480)	0.108*** (0.0391)	-0.0566*** (0.00397)	0.235*** (0.0598)
Years of work experience before marriage	-0.249*** (0.0193)	0.467 (0.513)	-0.0711*** (0.0147)	-0.209* (0.126)	0.197*** (0.0134)	0.0223 (0.216)
Years of work experience before marriage squared	0.0247*** (0.00185)	-0.0543 (0.0500)	0.0100*** (0.00149)	0.0385** (0.0164)	-0.0153*** (0.00140)	0.00951 (0.0170)
Lived with mother at t-2	-1.546*** (0.115)	2.579 (3.524)	-0.940*** (0.0553)	-2.725* (1.587)	-0.518*** (0.0413)	-0.0127 (0.575)
Lived in metropolitan at t-2	0.0509 (0.0514)	-0.308 (0.291)	-0.102*** (0.0397)	-0.283 (0.250)	0.0158 (0.0332)	0.0546 (0.101)
Education[b]						
A university graduate	0.282*** (0.0725)	-0.309 (0.688)	0.273*** (0.0568)	1.332*** (0.503)	0.0916* (0.0493)	1.058*** (0.184)

Table 5.5.1 continued

Dependent variable	First stage: r_i = 1 if in group A, r_i = 0 otherwise	Second stage: Log of husband's time in housework at t-2	First stage: r_i = 1 if in group B, r_i = 0 otherwise	Second stage: Log of husband's time in housework at t-2	First stage: r_i = 1 if in group C, r_i = 0 otherwise	Second stage: Log of husband's time in housework at t-2
A technical school or junior college graduate	0.180***	-0.316	0.245***	1.124***	0.00503	0.550***
	(0.0520)	(0.471)	(0.0372)	(0.411)	(0.0304)	(0.0915)
Woman's father is a university graduate	0.260***	0.124	0.0428	0.362	-0.193***	0.119
	(0.0611)	(0.616)	(0.0498)	(0.233)	(0.0459)	(0.261)
Woman's father is a technical school or junior college graduate	-0.0351	1.205**	0.352***	0.807	0.0517	0.168
	(0.108)	(0.562)	(0.0675)	(0.629)	(0.0623)	(0.189)
Woman's family background						
Went to private senior high school	-0.116**	0.166	0.0831**	-0.0116	0.0414	-0.0824
	(0.0510)	(0.366)	(0.0364)	(0.217)	(0.0307)	(0.101)
Non-first born daughter * number of siblings	-0.0353	0.250*	0.0326**	0.222**	-0.0312**	-0.00205
	(0.0244)	(0.152)	(0.0161)	(0.0968)	(0.0135)	(0.0528)
Region in which the woman grew up during primary and junior high school[e]						
Grew up in Hokkaido	-0.290**	-0.328	-0.0973	-1.155***	0.0646	-0.464**
	(0.127)	(0.866)	(0.0838)	(0.419)	(0.0678)	(0.217)
Grew up in Touhoku	-0.163*	0.735	-0.162**	-0.604	-0.0568	-0.260
	(0.0909)	(0.608)	(0.0668)	(0.420)	(0.0537)	(0.175)
Grew up in Kita-kanto	0.209**	-1.609***	0.145**	1.131***	-0.0396	0.139
	(0.0919)	(0.611)	(0.0715)	(0.402)	(0.0635)	(0.196)
Grew up in Tokai	-0.899***	1.488	-0.301**	0.301	0.0600	0.236
	(0.276)	(2.501)	(0.119)	(0.725)	(0.0856)	(0.254)

Table 5.5.1 continued

	First stage	Second stage	First stage	Second stage	First stage	Second stage
Dependent variable	r_i = 1 if in group A, r_i = 0 otherwise	Log of husband's time in housework at t-2	r_i = 1 if in group B, r_i = 0 otherwise	Log of husband's time in housework at t-2	r_i = 1 if in group C, r_i = 0 otherwise	Log of husband's time in housework at t-2
Grew up in Chubu	-0.0592	-0.0148	-0.144***	-0.717**	-0.0559	0.00851
	(0.0615)	(0.332)	(0.0466)	(0.309)	(0.0387)	(0.135)
Grew up in Chugoku	-0.115	-1.024*	-0.399***	-0.735	0.276***	0.153
	(0.0940)	(0.538)	(0.0799)	(0.780)	(0.0541)	(0.301)
Grew up in Shikoku	-0.211	0.930	0.134	0.352	-0.0511	-0.0367
	(0.136)	(0.831)	(0.0824)	(0.418)	(0.0722)	(0.226)
Grew up in Kyushuu or Okinawa	-0.359***	0.916	-0.0608	-0.167	-0.231***	-0.345
	(0.0871)	(0.912)	(0.0555)	(0.271)	(0.0499)	(0.289)
Constant	-41.36***	81.33	-41.07***	-214.6***	110.2***	-459.0***
	(13.06)	(117.5)	(9.440)	(79.25)	(7.804)	(115.5)
Pooled observations	11572	11572	11572	11572	11572	11572
Pooled uncensored observations	525		1225		2687	

Note: Pooled Two-Stage Heckman. Coefficients reported. All women including unmarried women, but excludes waves 1, 2 and 3. Standard errors in parentheses. Yearly dummies included.

[a] It is the value of assets plus 1.

[b] Shows highest educational attainment. Reference category is middle school and high school graduates.

[c] Indicates the region in which the woman grew up the longest during primary and junior high school. Reference category is Metropolitan Tokyo area (Shutoken) and Metropolitan Osaka area (Kansai area).

*** significant at 1%, ** significant at 5 %, * significant at 10%.

variable s_{it+1} is created which is equal to 1 if they drop from the sample in the following year, and is equal to zero if the observation remains in the sample in the following year. The attrition variable s_{it+1} is included in the estimations for the pooled IV Probit where the first stage is the log of the husband's time in housework and childcare on a non-workday and the second stage predicts fertility probability. The attrition variable s_{it+1} is added in both the first and second stage estimations. The pooled IV Probit model was discussed in the sections 5.3. We test for the significance of the coefficient on the attrition variable s_{it+1}. If the coefficient on s_{it+1} is significant, we suspect that s_{it+1} is correlated with the error terms causing biased estimates. We also test for attrition bias in the duration model where the first stage is the husband's time in housework and the second stage predicts the fertility probability given that they have not had a child until then. The duration model was discussed in 5.4.

The results in Table 5.5.2a show that the coefficient of s_{it+1} is not significant for both the first and second stages of the pooled IV Probit, indicating that there is no evidence of attrition bias. The results from the attrition bias test for the duration model are presented in Table 5.5.2b, and it also shows that the attrition variable s_{it+1} is not significant in all cases implying that attrition bias is unlikely to exist.

Next, we use the methodology outlined by Fitzgerald, Gottschalk and Moffitt (1998) to study the effects of the first year's characteristics on the probability of ever dropping out of the sample at some point by 2004 which is the last year of the available data using a probit model. The first year's characteristics, namely the 1993 and 1997 information, are used as independent variables to predict the probability of future attrition. The dependent variable "ever out of sample" is created and is equal to 1 if the respondent dropped out of the sample at some point by 2004, and is equal to zero if the respondent is always in the sample. 32.7 percent of the 1993 cohort and 31.5 percent of the 1997 cohort who were married in the first year attrited at some point by 2004. Of particular interest is whether the endogenous variables in our analysis, namely the husband's time in housework on a non-workday and the number of children predict future attrition, controlling for first year's socio-economic characteristics (such as education, husband's annual labor earnings, the wife's year born and age at marriage). If the endogenous variables are significant, it indicates that the endogenous variables have a correlation with future attrition and our estimations will cause an attrition bias.

Table 5.5.2a. Testing for Attrition Bias in the Pooled IV Probit Model

	Group A		Group B		Group C	
	First stage IV probit	Second stage IV probit	First stage IV probit	Second stage IV probit	First stage IV probit	Second stage IV probit
Attrition variable						
Attrition at t+1 (s_{it+1}) [a]	0.298	0.0620	0.418	-0.267	0.177	0.301
	(0.623)	(0.349)	(0.286)	(0.208)	(0.205)	(0.233)
Endogenous variable						
Predicted log of husband's time in housework at t-2		-0.275*		0.366***		0.114
		(0.167)		(0.109)		(0.328)
Instruments						
Husband's mother 25-30 at birth	0.211		-0.356**		0.282**	
	(0.287)		(0.152)		(0.139)	
Wife and Husband's mothers 31+ at birth	1.605***		-0.958*		-0.218	
	(0.602)		(0.557)		(0.460)	
Individual and household characteristics						
Wife's year born	0.0481	0.134***	0.0409	0.0757*	0.232***	0.0967
	(0.0473)	(0.0515)	(0.0368)	(0.0398)	(0.0252)	(0.0990)
Wife's age at marriage	0.0590	0.116**				
	(0.0621)	(0.0515)				
Wife's age at first birth			0.0711*	-0.00132	0.196***	-0.0135
			(0.0392)	(0.0262)	(0.0293)	(0.0688)
Lived with wife's mother at t-2	-0.0323	-0.0436	0.164	0.0304	0.0752	0.153
	(0.808)	(0.451)	(0.455)	(0.226)	(0.254)	(0.168)
Lived with husband's mother at t-2	-0.412	-0.309	-0.338	0.108	-0.431**	0.367***
	(0.388)	(0.211)	(0.253)	(0.134)	(0.183)	(0.140)
Lived in metropolitan at t-2	0.191	-0.243	-0.111	0.0819	-0.0248	0.100
	(0.308)	(0.250)	(0.223)	(0.109)	(0.182)	(0.126)
Log husband's annual labor earnings at t-2	-0.0435	0.000209	0.0559	-0.00361	-0.00790	0.0381

Table 5.5.2a continued.

	Group A		Group B		Group C	
	First stage IV probit	Second stage IV probit	First stage IV probit	Second stage IV probit	First stage IV probit	Second stage IV probit
	(0.0718)	(0.0440)	(0.0546)	(0.0358)	(0.0468)	(0.0397)
Log husband's annual property earnings at t-2	-0.0556	-0.00392	0.0178	-0.00568	0.0239	-0.00491
	(0.0400)	(0.0275)	(0.0241)	(0.0137)	(0.0159)	(0.0176)
Log of husband's annual state transfers at t-2			0.0309*	0.0102	0.0222**	0.0114
			(0.0159)	(0.0133)	(0.0104)	(0.0133)
Wife's years of work experience before marriage	-0.0400	0.0362	0.0516	-0.0260	0.0665	0.0980
	(0.102)	(0.0912)	(0.0922)	(0.0510)	(0.0772)	(0.0632)
Wife's years of work experience before marriage square	0.00295	-0.00522	0.000234	0.00247	-0.00726	-0.00369
	(0.00866)	(0.00838)	(0.00922)	(0.00581)	(0.00916)	(0.00620)
First child is a girl * husband is firstborn son			0.376**	-0.0814		
			(0.191)	(0.112)		
Wife is 2 years or more older than husband	0.497	-0.263	0.528	-0.161	0.0897	0.378
	(0.597)	(0.337)	(0.323)	(0.194)	(0.495)	(0.299)
Husband is 10 years or more older than wife	-0.262	-0.607*	0.527	-0.416*	-0.0324	0.185
	(0.676)	(0.354)	(0.468)	(0.235)	(0.395)	(0.248)
Education[b]						
Wife a university grad	0.114	0.154	0.498*	-0.122	0.317	0.202
	(0.480)	(0.245)	(0.282)	(0.167)	(0.262)	(0.244)
Husband a university grad	0.937***	0.304	-0.481**	0.271**	0.0224	-0.275**
	(0.360)	(0.216)	(0.214)	(0.118)	(0.188)	(0.140)
Wife a technical school, junior college	-0.439	0.0399	0.439**	-0.194*	0.115	0.236*
	(0.349)	(0.199)	(0.204)	(0.112)	(0.174)	(0.142)
Husband a technical school, junior college grad	-0.0576	-0.0811	-0.752**	0.333**	-0.0805	-0.237
	(0.413)	(0.247)	(0.320)	(0.157)	(0.206)	(0.150)
Husband's father a university grad	-0.302	0.0242	0.342	-0.169	0.307	0.0724
	(0.437)	(0.233)	(0.223)	(0.125)	(0.234)	(0.199)

Table 5.5.2a continued.

	Group A		Group B		Group C	
	First stage IV probit	Second stage IV probit	First stage IV probit	Second stage IV probit	First stage IV probit	Second stage IV probit
Husband's father a technical school, junior college grad	-0.546	-0.0490	0.256	-0.330	-0.183	-0.474
	(0.830)	(0.368)	(0.313)	(0.219)	(0.234)	(0.438)
Family background						
Husband went to private high school	-0.238	0.172	0.219	-0.288***	-0.0131	-0.0455
	(0.326)	(0.229)	(0.192)	(0.109)	(0.178)	(0.119)
Husband non firstborn son * number of siblings	-0.107	-0.0153	-0.170**	0.0190	0.132	-0.0323
	(0.310)	(0.113)	(0.0781)	(0.0607)	(0.0949)	(0.0627)
Wife non-first born daughter * number of Siblings	0.175	0.150	-0.00384	-0.0954	0.186**	-0.0617
	(0.255)	(0.115)	(0.108)	(0.0671)	(0.0818)	(0.0699)
Husband is firstborn son * wife is firstborn Daughter	-0.152	-0.143	-0.310	-0.0995	0.537**	-0.270
	(0.553)	(0.241)	(0.256)	(0.154)	(0.226)	(0.186)
Region in which husband grew up during primary and junior high school [c]						
Husband grew up in Hokkaido	-0.490	0.0832	-0.697**	0.183	-0.690*	0.484*
	(0.605)	(0.348)	(0.348)	(0.215)	(0.380)	(0.276)
Husband grew up in Touhoku	-0.162	0.504	0.177	0.00101	-0.397	0.00693
	(0.515)	(0.372)	(0.306)	(0.160)	(0.310)	(0.216)
Husband grew up in Kita-kanto	-0.412	-0.247	-0.0475	-0.0673	0.139	-0.149
	(0.535)	(0.480)	(0.452)	(0.262)	(0.379)	(0.217)
Husband grew up in Tokai	1.380	0.399	-0.278	0.309	0.298	0.593*
	(0.919)	(0.425)	(0.339)	(0.243)	(0.454)	(0.332)
Husband grew up in Chubu	-0.240	0.155	-0.476*	0.188	-0.0472	0.115
	(0.407)	(0.218)	(0.269)	(0.132)	(0.188)	(0.130)
Husband grew up in Shikoku	-3.175***	-0.868	-0.213	0.0806	-0.237	0.0239
	(0.679)	(0.637)	(0.579)	(0.271)	(0.430)	(0.302)
Husband grew up in Kyushuu			0.150	-0.173	-0.587***	0.201
			(0.260)	(0.132)	(0.226)	(0.228)

Table 5.5.2a continued.

	Group A		Group B		Group C	
	First stage IV probit	Second stage IV probit	First stage IV probit	Second stage IV probit	First stage IV probit	Second stage IV probit
Husband grew up in Okinawa			0.711	0.366	-0.290	0.635*
			(0.705)	(0.338)	(0.473)	(0.358)
Husband grew up in Kyushuu or Okinawa [d]	-0.654	0.125				
	(0.449)	(0.305)				
Constant	-93.29	-265.9***	-79.16	-150.5*	-456.3***	-192.3
	(93.43)	(102.7)	(73.18)	(78.59)	(49.65)	(195.2)
Observations	548	548	1,381	1,381	2,990	2,990

Note: Coefficients reported. Cluster standard errors in parentheses. Yearly dummies included.

[a] An attrition variable s_{it+1} is equal to 1 if they drop from the sample in the following year, and is equal to zero if the observation remains in the sample in the following year.

[b] Shows highest educational attainment. Reference category is middle school and high school graduates.

[c] Indicates the region in which the husband grew up the longest during primary and junior high school. Reference category is Metropolitan Tokyo area (Shutoken) and Metropolitan Osaka area (Kansai area).

[d] For group A, husbands that grew up in Kyushu is group with those that grew up in Okinawa because of the number of observations is small.

*** significant at 1%, ** significant at 5 %, * significant at 10%.

Table 5.5.2b. Testing for Attrition Bias in the Duration Model

	Group A		Group B		Group C	
	First Stage	Second stage	First stage	Second stage	First stage	Second stage
	Husband's time in housework[a]	First baby born[b]	Husband's time in housework[a]	Second baby born[c]	Husband's time in housework[a]	Third baby born[d]
Attrition variable						
Attrition at t+1 (s_{it+1}) [e]	0.328 (0.648)	0.323 (0.937)	0.361 (0.277)	-0.596 (0.635)	0.149 (0.214)	0.623 (0.499)
Instruments						
Husband's mother 25-30 at birth	0.265 (0.322)		-0.250 (0.186)		0.273* (0.152)	
Wife and Husband's mothers 31+ at birth	1.608** (0.631)		-1.023** (0.491)		-0.535 (0.491)	
Endogenous variable						
Predicted log of husband's time in housework at t-2		-0.626 (0.926)		0.813 (0.588)		0.340 (0.661)
Duration variables						
Duration of marriage 0-4 at *t*	0.0196 (0.462)	2.495* (1.475)				
Duration of marriage 5-8 at *t*	0.110 (0.387)	1.954 (1.407)				
1 year before first child born at *t-2* (or 1 year since first birth at *t)*			-1.497*** (0.302)	2.170** (1.036)		
First child is age 0-5 at *t-2* (or 2-7 year since first birth at *t)*			1.114*** (0.238)	1.409* (0.815)		
1 year before second child born at *t-2* (or 1 year since second birth at *t)*					0.715*** (0.174)	0.218 (0.622)

Table 5.5.2b continued

	Group A		Group B		Group C	
	First stage	Second stage	First stage	Second stage	First stage	Second stage
	Husband's time in housework[a]	First baby born[b]	Husband's time in housework[a]	Second baby born[c]	Husband's time in housework[a]	Third baby born[d]
Second child is age 0-2 at *t-2* (or 2-4 years since second birth at *t*)					0.897*** (0.121)	0.995 (0.634)
Individual and household characteristics						
Wife's age at marriage	0.0464 (0.0697)	0.0107 (0.0959)				
Wife's age at first birth			0.0418 (0.0308)	-0.168*** (0.0505)	0.121*** (0.0347)	-0.121 (0.0939)
Lived with wife's mother at t-2	-0.242 (0.866)	-0.264 (1.308)	0.139 (0.424)	0.000627 (0.460)	-0.142 (0.262)	0.267 (0.404)
Lived with husband's mother at t-2	-0.461 (0.410)	-0.711 (0.760)	-0.428* (0.247)	0.193 (0.380)	-0.556*** (0.190)	0.832* (0.449)
Lived in metropolitan at t-2	0.213 (0.322)	-0.498 (0.568)	-0.204 (0.216)	0.144 (0.255)	-0.144 (0.191)	0.249 (0.318)
Log husband's annual labor earnings at t-2	-0.0467 (0.0744)	-0.0224 (0.237)	0.0448 (0.0459)	-0.00353 (0.107)	-0.0305 (0.0459)	0.0370 (0.0933)
Log husband's annual property earnings at t-2	-0.0601 (0.0425)	-0.0127 (0.0803)	0.00326 (0.0228)	-0.0135 (0.0279)	0.0186 (0.0165)	-0.00527 (0.0400)
Log of husband's annual state transfers at t-2			0.00651 (0.0144)	0.0399** (0.0191)	0.0397*** (0.0106)	0.0209 (0.0329)
Wife's years of work experience before marriage	-0.0850 (0.108)	0.0188 (0.281)	-0.0338 (0.0853)	-0.0914 (0.115)	-0.0405 (0.0834)	0.154 (0.143)
Wife's years of work experience before marriage squared	0.00428 (0.00932)	-0.00953 (0.0318)	0.00447 (0.00878)	0.00745 (0.0144)	-0.00202 (0.0100)	-0.00865 (0.0154)

Table 5.5.2b continued

	Group A		Group B		Group C	
	First stage	Second stage	First stage	Second stage	First stage	Second stage
	Husband's time in housework[a]	First baby born[b]	Husband's time in housework[a]	Second baby born[c]	Husband's time in housework[a]	Third baby born[d]
First child is a girl * husband is firstborn son			0.324* (0.180)	-0.182 (0.291)		
Wife is 2 years or more older than husband	0.483 (0.621)	-0.588 (0.975)	0.568* (0.321)	-0.335 (0.564)	0.139 (0.509)	0.676 (0.754)
Husband is 10 years or more older than wife	-0.143 (0.688)	-1.282 (1.109)	0.391 (0.437)	-0.910 (0.659)	0.204 (0.375)	0.663 (0.669)
<u>Education</u>[f]						
Wife a university grad	0.0544 (0.494)	0.322 (0.704)	0.351 (0.274)	-0.300 (0.394)	0.0448 (0.264)	0.201 (0.493)
Husband a university grad	0.868** (0.368)	0.531 (0.989)	-0.383* (0.204)	0.622* (0.338)	-0.0146 (0.202)	-0.715** (0.350)
Wife a technical school, junior college	-0.402 (0.364)	0.0856 (0.615)	0.400** (0.197)	-0.466 (0.305)	0.0202 (0.181)	0.372 (0.287)
Husband a technical school, junior college grad	-0.0776 (0.430)	-0.354 (0.788)	-0.686** (0.322)	0.773 (0.532)	-0.00721 (0.222)	-0.454 (0.343)
Husband's father a university Grad	-0.268 (0.447)	0.0654 (0.653)	0.358 (0.222)	-0.387 (0.352)	0.350 (0.230)	0.241 (0.452)
Husband's father a technical school, junior college grad	-0.482 (0.872)	-0.161 (1.000)	0.132 (0.282)	-0.715 (0.603)	-0.234 (0.269)	-1.116* (0.596)
<u>Family background</u>						
Husband went to private senior high school	-0.229 (0.342)	0.319 (0.559)	0.208 (0.185)	-0.722*** (0.256)	0.0509 (0.189)	-0.0751 (0.304)

Table 5.5.2b continued

	Group A		Group B		Group C	
	First stage	Second stage	First stage	Second stage	First stage	Second stage
	Husband's time in housework[a]	First baby born[b]	Husband's time in housework[a]	Second baby born[c]	Husband's time in housework[a]	Third baby born[d]
Husband non firstborn son * number of siblings	-0.129	-0.111	-0.144*	0.0247	0.119	-0.0871
	(0.332)	(0.368)	(0.0753)	(0.158)	(0.0985)	(0.172)
Wife non-first born daughter * number of siblings	0.173	0.250	0.00723	-0.271*	0.150*	-0.174
	(0.268)	(0.365)	(0.106)	(0.146)	(0.0878)	(0.168)
Husband is firstborn son * wife is firstborn daughter	-0.198	-0.494	-0.253	-0.343	0.555**	-0.595
	(0.580)	(0.783)	(0.249)	(0.317)	(0.237)	(0.497)
Region in which husband grew up during primary and junior high school[g]						
Husband grew up in Hokkaido	-0.607	0.00388	-0.705**	0.344	-0.880**	1.222
	(0.623)	(1.141)	(0.327)	(0.570)	(0.357)	(0.809)
Husband grew up in Touhoku	-0.123	0.977	0.102	-0.0606	-0.306	0.148
	(0.494)	(1.209)	(0.311)	(0.355)	(0.327)	(0.491)
Husband grew up in Kita-kanto	-0.472	-0.698	-0.0356	-0.325	-0.00577	-0.266
	(0.577)	(1.846)	(0.445)	(0.586)	(0.384)	(0.624)
Husband grew up in Tokai	1.385	0.837	-0.234	0.809	0.389	1.303**
	(0.972)	(1.926)	(0.312)	(0.718)	(0.515)	(0.653)
Husband grew up in Chubu	-0.185	0.421	-0.458*	0.369	-0.0230	0.377
	(0.425)	(0.563)	(0.257)	(0.365)	(0.209)	(0.312)
Husband grew up in Shikoku	-3.025***	-1.802	-0.0795	0.182	-0.0271	0.207
	(0.708)	(2.996)	(0.584)	(0.537)	(0.458)	(0.731)
Husband grew up in Kyushuu			0.0162	-0.440	-0.605**	0.598
			(0.251)	(0.314)	(0.256)	(0.572)
Husband grew up in Okinawa			1.343*	0.864	-0.150	1.435**
			(0.699)	(1.061)	(0.384)	(0.633)
Husband grew up in Kyushuu or	-0.622	0.270				

Table 5.2.2b continued

	Group A		Group B		Group C	
	First stage	Second stage	First stage	Second stage	First stage	Second stage
	Husband's time in housework[a]	First baby born[b]	Husband's time in housework[a]	Second baby born[c]	Husband's time in housework[a]	Third baby born[d]
Okinawa[h]	(0.457)	(0.855)				
Constant	1.705	-1.900	2.027*		0.814	-2.743
	(2.157)	(4.914)	(1.177)		(1.045)	(2.059)
Pooled observations	548		1,381		2,990	
R-squared	0.143		0.268		0.142	

Note: Yearly dummies included.

[a] OLS coefficients reported and cluster standard errors in parentheses.

[b] Logit coefficients reported and bootstrap cluster standard errors in parentheses. 622 complete replications.

[c] Logit coefficients reported and bootstrap cluster standard errors in parentheses. 1047 complete replications.

[d] Logit coefficients reported and bootstrap cluster standard errors in parentheses. 733 complete replications.

[e] Attrition =1 if attrite at t+1, attrition=0 if remain in the sample at t+1.

[f] Shows highest educational attainment. Reference category for wife is middle school and high school graduates, and for husband is middle school and high school graduates.

[g] Indicates the region in which the husband grew up the longest during primary and junior high school. Reference category is Metropolitan Tokyo area (Shutoken) and Metropolitan Osaka area (Kansai area) and Chugoku.

[h] For group A, husbands that grew up in Kyushu is grouped with those who grew up in Okinawa because of the number of observations is small.

*** significant at 1%, ** significant at 5 %, * significant at 10%.

Table 5.5.2c. Ever-Out Attrition Probits Based on First Year's Characteristics

	1993 cohort all women	1997 cohort all women
Married in first year	-0.182	-0.469**
	(0.127)	(0.201)
Year born	0.00514	-0.0595
	(0.0122)	(0.0562)
Number of children in first year	-0.00277	-0.148
	(0.0453)	(0.108)
Lives with mother in first year	0.00580	-0.306*
	(0.112)	(0.167)
University graduate	0.00634	-0.137
	(0.109)	(0.169)
Technical school, junior college	-0.0151	-0.325**
	(0.0728)	(0.132)
Lives in a metropolitan area in first Year	0.119	-0.00775
	(0.0772)	(0.132)
Constant	-10.33	117.5
	(24.03)	(110.8)
Observations	1500	500
Pseudo R-squared	0.0062	0.0273
Loglikelihood	-982.78904	-322.01254

Note: All women including those who are unmarried in first year. Coefficients reported. Dependent variable: Ever out of the sample =1 if dropped at some point during the sample, and ever out = 0 if always in sample1993 characteristics for the 1993 cohort and 1997 characteristics for the 1997 cohort. Robust standard errors in parentheses.

*** significant at 1%, ** significant at 5 %, * significant at 10%.

We use two subsets of sample of all women in 1993 and 1997, and a subset of women who were married in the first year and who reported on their husbands' time use. The former is presented in Table 5.5.2c and the latter in Table 5.5.2d. We only use a small number of covariates for this test following the method applied by Fitzgerald *et al* (1998) who test for the significance of the endogenous variables starting from only a few covariates. Once they find that the endogenous variables are significant (i.e. attrition bias is likely to be present), they expand the specification by adding more covariates. This is because starting with a more parsimonious specification can inform us whether an attrition bias is present.

The results show that the number of children in the first year does not have a significant effect on future attrition. Further, the husband's time in housework does not affect future attrition in Table 5.5.2c and results are consistent for both the 1993 and 1997 cohorts. Therefore, we can conclude that there is little evidence of attrition bias for our estimation purposes.

Table 5.5.2d. Ever-Out Attrition Probits Based on First Year's Characteristics

	1993 cohort and married in 1993	1997 cohort and married in 1997
Number of children	-0.0628	0.0570
	(0.0655)	(0.201)
Log of husband's time in housework in first year	0.00403	-0.0718
	(0.0200)	(0.0448)
Year wife born	-0.0199	-0.149
	(0.0188)	(0.121)
Age at marriage	-0.0569***	0.0822
	(0.0221)	(0.0860)
Wife is 2 years or more older than husband	0.136	-0.272
	(0.230)	(0.765)
Husband is 10 years or more older than wife	-0.0487	0.577
	(0.199)	(0.468)
Wife a university grad	-0.113	-1.054**
	(0.189)	(0.533)
Husband a university grad	0.0904	0.458
	(0.111)	(0.287)
Wife a technical school, junior college	0.0996	-0.582**
	(0.104)	(0.252)
Lives with wife's mother in first year	-0.106	-0.193
	(0.188)	(0.477)
Lives with husband's mother in first year	0.0610	-0.283
	(0.105)	(0.335)
Lives in a metropolitan area in first year	0.121	-0.385
	(0.110)	(0.268)
Log of husband's annual labor earnings the year before the first year[a]	0.112*	-0.187
	(0.0579)	(0.349)
Constant	38.25	295.5
	(37.28)	(240.4)
Observations	833	159
Number of observations that were ever out of the sample	273	50
Log-likelihood	-520.11643	-90.523724

Note: Only includes women who were married in the first year. Coefficients reported. Dependent variable: Ever out of the sample =1 if dropped at some point during the sample, and ever out =0 if always in sample. 1993 characteristics for the 1993 cohort and 1997 characteristics for the 1997 cohort. Robust standard errors in parentheses.

[a] The survey asks for the previous year's husband's earnings.

*** significant at 1%, ** significant at 5 %, * significant at 10%.

However, women who were married in the first year of panel in the 1997 cohort face a lower probability of future attrition. However, the pseudo-R squared is low at 0.027 and therefore the size of the bias caused is likely to be small. We test whether the changes in marital status has an effect on attrition in the following section.

5.5.3 Testing for Attrition Bias on Observable Characteristics

Fitzgerald, Gottschalk and Moffitt (1998) test whether there are attrition biases based on observable characteristics. This occurs when attrition can be determined by an observed variable, say *z* that does not technically belong in the equation of interest (Fitzgerald *et al* 1998). Fitzgerald *et al* (1998) shows that this is problematic because we cannot estimate the mean value of the dependent variable *y* conditional on the exogenous variables, because *z* affects *y* through the attrition probabilities. Given that the marital status in the first year affect future attrition for the 1997 cohort as shown in the previous section, we test whether marital status affects attrition and whether individuals who experience changes in marital status are likely to attrite.

A dynamic attrition hazard model is estimated using the methodology outlined by Fitzgerald *et al* (1998). The probability of attriting in the next period conditional on being in the sample in the current period is estimated using a logit model. The dependent variable attrition is equal to one if the individual attrites at t+1, and is equal to zero if it remains in the sample.

We use two sub-samples consisting of all women including unmarried women, and a sample of only married women. The covariates include education, the year the wife is born, whether they live with their mother and whether they live in a metropolitan area. For the sub-sample of only married women, we include additional variables such as the wife's age at marriage, the husband's education, the number of children, the husband's time in housework on a non-workday and his annual labor earnings.

Following Fitzgerald *et al* (1998), we create three sets of variables related to the change in marital status: the average probability of being married from the first year until the current year; dummy variables indicating whether they are currently married, recently divorced or newly wedded in the last 12 months; and the number of years since the last marital transition[59]. Table 5.5.3 presents the estimation results.

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59. This is the number the years since being married or divorced. If the woman was never married, then the number of years since age 16 is used since the legal age of marriage is 16 for women.

Again, the dependent variables on the number of children and the husband's time spent in housework do not significantly affect attrition in the next period. Regarding the changes in marital status, the probability of being married from the first year to the current period, or whether a woman is currently married, recently divorced or newly wedded do not have an effect on attrition. However, women who have not recently experienced a change in marital status have a lower probability of attrition in the subsequent period, shown by the negative coefficient on the years since the last marital transition. Hence we find that stability in marital status has an impact on attrition, although the pseudo R-squared values are less than 0.0172, which suggests that the bias caused by the stability in marital status is likely to be small. Moreover, for the duration model, when we estimate birth probabilities (discussed in section 5.4), we take into account the marriage duration to predict the first birth, and the time elapsed since last birth to predict the second and third births. Because the time elapsed since last birth is highly correlated with marriage duration, attrition bias will be removed as it legitimately belongs in the right hand side variables. Therefore, we can conclude that there is little evidence of a selection bias and attrition bias for our estimations.

Table 5.5.3. Dynamic Attrition Models with a Focus on Marital Status

Variables	All women pooled	Only married women pooled
Probability of being married from first year until current year	-0.289	-1.677
	(0.790)	(1.153)
Married at *t*	-0.302	
	(0.757)	
Divorced in last 12 months	-0.368	
	(0.529)	
Newly married in last 12 months	0.409	-0.0797
	(0.434)	(0.552)
Number of years since the last marital transition[a]	-0.0311***	-0.0453**
	(0.00864)	(0.0191)
Year born	-0.00114	-0.0411*
	(0.0116)	(0.0212)
Wife a university grad	-0.0248	-0.0407
	(0.118)	(0.185)
Wife a technical school, junior college	-0.131	-0.135
	(0.0864)	(0.116)
Lives in a metropolitan area at *t*	0.127	0.193
	(0.0873)	(0.118)
Lives with wife's mother at *t*	0.0375	-0.0716
	(0.116)	(0.220)
Age at marriage		-0.0896***
		(0.0250)
Number of children at *t*		-0.101
		(0.0701)
Log of husband's time in housework on a non workday at *t*		-0.0161
		(0.0241)
Husband a university grad		0.185
		(0.119)
Lives with husband's mother at *t*		0.0454
		(0.125)
Log of husband's prior year's annual labor earnings		0.00853
		(0.0507)
Constant	-0.346	81.55*
	(22.87)	(42.38)
Pooled observations	17,286	10,837
Number of attrition	742	400
Pseudo R-squared	0.0172	0.0129
Log-likelihood	-3,009.0786	-1,690.1527

Note: Logit coefficients reported. Dependent Variable Attrition =1 if attrite at t+1, attrition=0 if remain in the sample at t+1.Cluster standard errors in parentheses. Yearly dummies included.

[a] If the individual has never been married, the duration since last marital transition is current age minus 16 since 16 is the legal age of marriage for women.

*** significant at 1%, ** significant at 5 %, * significant at 10%.

CHAPTER 6

RESULTS

In this chapter, we present the results from the first approach using the pooled IV Probit Model in sections 6.1 and 6.2. The IV Probit addresses the question, "Does the husband's time spent in housework increase the birth probability, and does it only increase the probability for the second birth?" The estimations from the second approach using the duration model are presented in sections 6.3 and 6.4. In the duration model, we ask, "does the husband's time in housework affect the timing of birth given that they did not have a birth until then?" We take into account of spacing of births by estimating time specific birth probability in the latter, while the former ignores spacing.

6.1 Results from the First Approach: Pooled IV Probit Model

6.1.1 First Stage of IV Probit Model: Husband's Time in Housework

The first stage of the IV Probit estimating the log of the husband's time in housework on a non-workday at *t-2* is presented in Table 6.1 for groups A, B and C.[60] In our discussions, we suppress the term non-workday at *t-2* for brevity. Cluster standard errors are shown in the brackets in the tables.

Following convention, tests of under-identification and over-identification restrictions are conducted by estimating equations 5.4.1 and 5.4.2 as a linear probability model with instruments, in other words, by using an IV regression. Using the F statistic, the instruments are jointly significant for A and B but is only marginally significant for C at 10 percent. We therefore suspect that the instruments are weak for C and the results have to be interpreted with caution. Hansen J-statistic which tests the null hypothesis that instruments are valid cannot be rejected and therefore the instruments are valid for all three cases (Cameron and Trivedi 2009). The under-identification test using the Kleibergen-Paap rank statistic shows that the matrix of reduced form is not under-identified for all three groups.

60. More accurately, is the log of husband's time plus 1 minute.

Table 6.1. First Stage of IV Probit

	First stage IV probit Group A	First stage IV probit Group B	First stage IV probit Group C
Instruments			
Husband's mother age 26-30 at birth	0.205	-0.356**	0.282**
	(0.286)	(0.152)	(0.139)
Wife and Husband's mothers 31+ at birth	1.603***	-0.959*	-0.215
	(0.607)	(0.559)	(0.461)
Individual and household characteristics			
Wife's year born	0.0488	0.0384	0.232***
	(0.0474)	(0.0369)	(0.0252)
Wife's age at first birth		0.0695*	0.196***
		(0.0392)	(0.0293)
Wife's age at marriage	0.0596		
	(0.0624)		
Lived with wife's mother at t-2	-0.0239	0.146	0.0705
	(0.802)	(0.454)	(0.254)
Lived with husband's mother at t-2	-0.384	-0.347	-0.430**
	(0.382)	(0.252)	(0.183)
Lived in metropolitan at t-2	0.177	-0.106	-0.0254
	(0.307)	(0.223)	(0.182)
Log husband's annual labor earnings at t-2	-0.0436	0.0553	-0.00755
	(0.0722)	(0.0547)	(0.0467)
Log husband's annual property earnings at t-2	-0.0554	0.0177	0.0240
	(0.0401)	(0.0241)	(0.0159)
Log of husband's annual state transfers at t-2		0.0303*	0.0221**
		(0.0158)	(0.0104)
Wife's years of work experience before marriage	-0.0431	0.0478	0.0629
	(0.102)	(0.0924)	(0.0769)
Wife's years of work experience before marriage squared	0.00313	0.000612	-0.00703
	(0.00873)	(0.00920)	(0.00914)
First child is a girl * husband is firstborn son		0.379**	
		(0.190)	
Wife is 2 years or more older than husband	0.497	0.529	0.0872
	(0.595)	(0.323)	(0.496)
Husband is 10 years or more older than wife	-0.200	0.521	-0.0348
	(0.686)	(0.465)	(0.395)
Education[a]			
Wife a university grad	0.138	0.505*	0.313
	(0.477)	(0.281)	(0.262)
Husband a university grad	0.948***	-0.475**	0.0235
	(0.362)	(0.214)	(0.188)
Wife a technical school, junior college	-0.433	0.439**	0.115
	(0.349)	(0.204)	(0.174)

Table 6.1 continued

	First stage IV probit Group A	First stage IV probit Group B	First stage IV probit Group C
Husband a technical school, junior college grad	-0.0541	-0.745**	-0.0819
	(0.414)	(0.320)	(0.206)
Husband's father a university grad	-0.299	0.342	0.311
	(0.437)	(0.223)	(0.234)
Husband's father a technical school, junior college grad	-0.553	0.261	-0.181
	(0.824)	(0.309)	(0.235)
<u>Family Background</u>			
Husband went to private high school	-0.221	0.220	-0.0127
	(0.332)	(0.192)	(0.178)
Husband non firstborn son * number of Siblings	-0.104	-0.170**	0.132
	(0.310)	(0.0778)	(0.0949)
Wife non-first born daughter * number of Siblings	0.178	-0.00283	0.185**
	(0.255)	(0.108)	(0.0816)
Husband is firstborn son * wife is firstborn Daughter	-0.160	-0.310	0.536**
	(0.555)	(0.256)	(0.226)
<u>Region in which husband grew up during primary and junior high school</u> [b]			
Husband grew up in Hokkaido	-0.495	-0.704**	-0.692*
	(0.603)	(0.350)	(0.380)
Husband grew up in Touhoku	-0.155	0.181	-0.400
	(0.511)	(0.304)	(0.310)
Husband grew up in Kita-kanto	-0.416	-0.0357	0.137
	(0.531)	(0.451)	(0.379)
Husband grew up in Tokai	1.401	-0.284	0.294
	(0.908)	(0.339)	(0.455)
Husband grew up in Chubu	-0.241	-0.472*	-0.0479
	(0.407)	(0.269)	(0.189)
Husband grew up in Shikoku	-3.216***	-0.204	-0.238
	(0.675)	(0.577)	(0.430)
Husband grew up in Kyushuu		0.150	-0.587***
		(0.260)	(0.226)
Husband grew up in Okinawa		0.802	-0.287
		(0.715)	(0.467)
Husband grew up in Kyushuu or Okinawa [c]	-0.641		
	(0.453)		
Constant	-94.64	-74.07	-455.9***
	(93.60)	(73.26)	(49.65)
Observations	548	1,381	2,990
<u>Test</u>			
Joint significance of instruments chi-square test	6.94**	6.54**	4.74*

Table 6.1 continued

	First stage IV probit Group A	First stage IV probit Group B	First stage IV probit Group C
<u>Tests from IV Reg</u>			
Kleibergen-Paap LM rank statistic	4.648*	5.870*	4.63*
Hansen J statistic	0.252	1.927	0.479
F statistic	3.24**	3.04**	2.31*

Note: Coefficients reported. Yearly dummies included. Dependent Variable: Log of husband's Time in Housework and Childcare on Non-workday at t-2. Cluster standard errors in parentheses.

[a] Shows highest educational attainment. Reference category for wife is middle school and high school graduates, and for husband is middle school and high school graduates.

[b] Indicates the region in which the husband grew up the longest during primary and junior high school. Reference category is Metropolitan Tokyo area (Shutoken), Metropolitan Osaka area (Kansai area) and Chugoku.

[c] For group A, husbands who grew up in Okinawa is grouped with those that grew up in Kyushu because of the number of observations is small.

*** significant at 1%, ** significant at 5 %, * significant at 10%.

For group A, the interaction variable indicating that the husband's mother and wife's mother were 31 or older at their births has a positive effect on the husband's time spent in housework. But it has a negative effect on the husband's time spent for group B. When the husband's mother was between ages 26to 30 when he was born has a positive effect on his contribution to housework for group C, yet has a negative effect for group B. The effects of the instruments indicate that they move in different directions.

In order to ensure that this result does not reflect the difference in age distributions for each group, we use two methods. Firstly, we compare the mean age of the husband's mother at birth by each group presented in Table 6.1a. The mean age for each group is about 27 years old and there is no statistical difference in the mean values. The only difference is revealed in the maximum ages. The maximum age is lower for A (39) than for B and C (45 and 43). We also compare the age of the wife's mother at her birth. For the wife, we find that the wife's mother's age at birth for A (28.1 years) is about one year older than for C (27.1) and the difference in mean values is statistically significant. (The differences in the mean values between A and B, and between B and C are not significant). However, if the age of the wife's mother at birth has an effect on her daughter's age at birth, we controlled for this by including the wife's age at first birth (for B and C), and the wife's age at marriage (for A).[61] Therefore, we do not expect the wife's mother's age at birth to have an independent effect on the unobservable characteristics predicting fertility after controlling for the observable variables.

Table 6.1a. Age of Husband's Mother at His Birth and Age of Wife's Mother at Her Birth by Group

Age of husband's mother at his birth	Pooled observations	Mean	Standard deviation	Min	Max
Group A	548	26.97	4.00	19	39
Group B	1,381	27.08	3.88	18	45
Group C	2,990	27.09	4.35	18	43
Age of wife's mother at her birth	**Pooled observations**	**Mean**	**Standard Deviation**	**Min**	**Max**
Group A	548	28.13	4.36	19	44
Group B	1,381	27.84	4.04	18	44
Group C	2,990	27.12	3.97	18	42

Secondly, we analyze the kernel density distributions of the husband's mother age and the wife's mother's age at birth by comparing the distributions by group shown in figures 6.1 and 6.2, respectively.

For the husband's mother, the age of the mother at birth is similarly distributed by each group. Group C's distribution lies slightly to the left of A and B. For the wife's mother, the difference in the distribution is pronounced between A and C, where C's distribution lies to left of A (i.e. at a younger age).

In summary, the difference in the mean values of the husband's mother at birth is not significantly different between groups. The only difference is seen in the maximum ages of the distributions. The opposite direction of the instruments shown in the first stage IV Probit result may reflect this difference. The mean wife's mother at birth for A is significantly different than C, including its distributions. But we controlled for the difference by including wife's age at first birth (B and C) and age at marriage (A).

61. The correlation coefficient between the wife's mother's age at their birth and wife's at first birth is 0.1 for B and C. For the wife's mother's age at birth and wife's at marriage, it is 0.04 for A. As mentioned before, the wife's age at marriage is a good proxy for wife's age at first birth as they are highly correlated (for B and C) at 0.84.

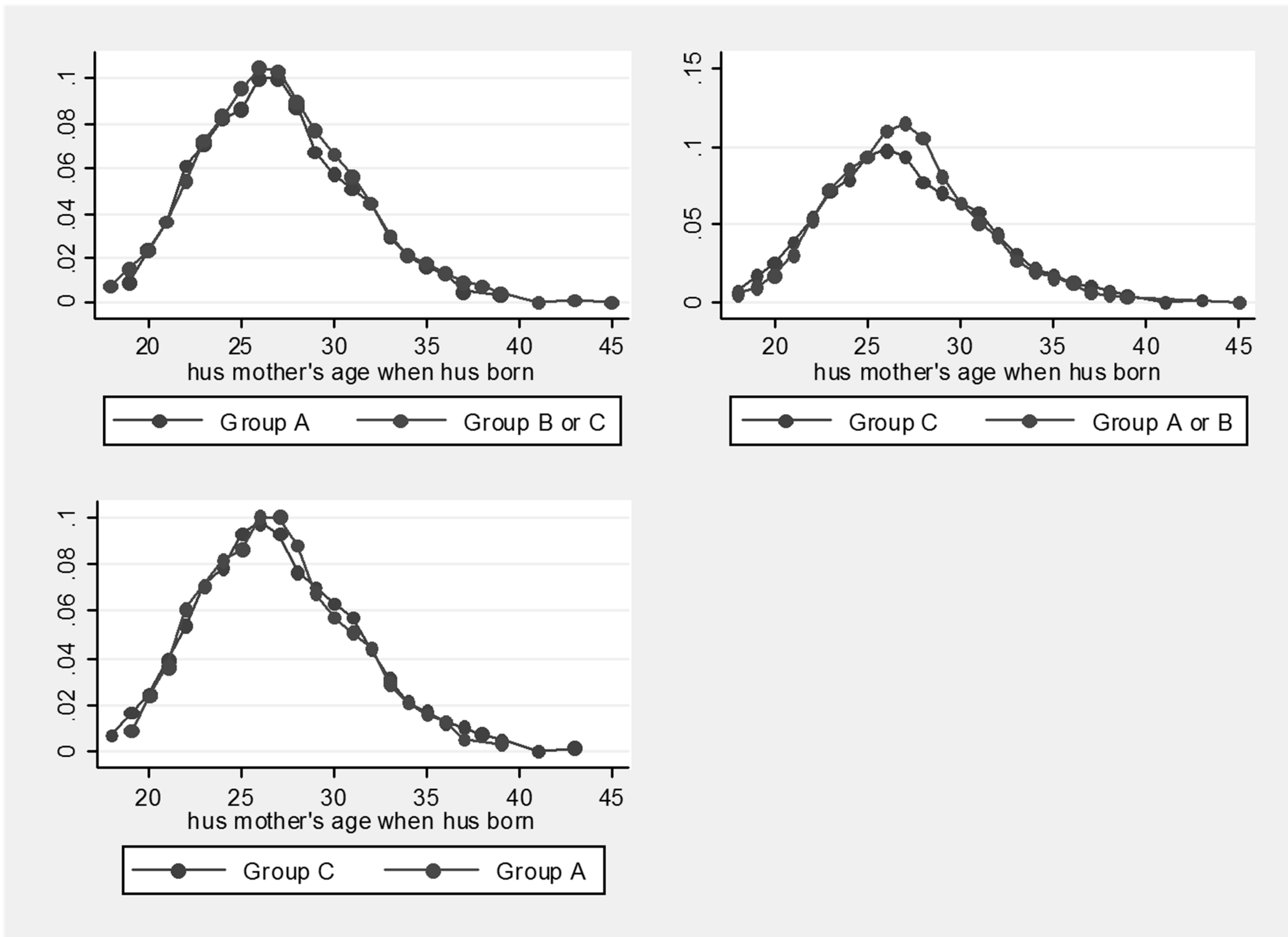

Figure 6.1. Kernel Density Distribution of the Husband's Mother at His Birth by Group. *Note*: Japanese Panel Survey of Consumers 1993-2003, Based on the Author's Calculations.

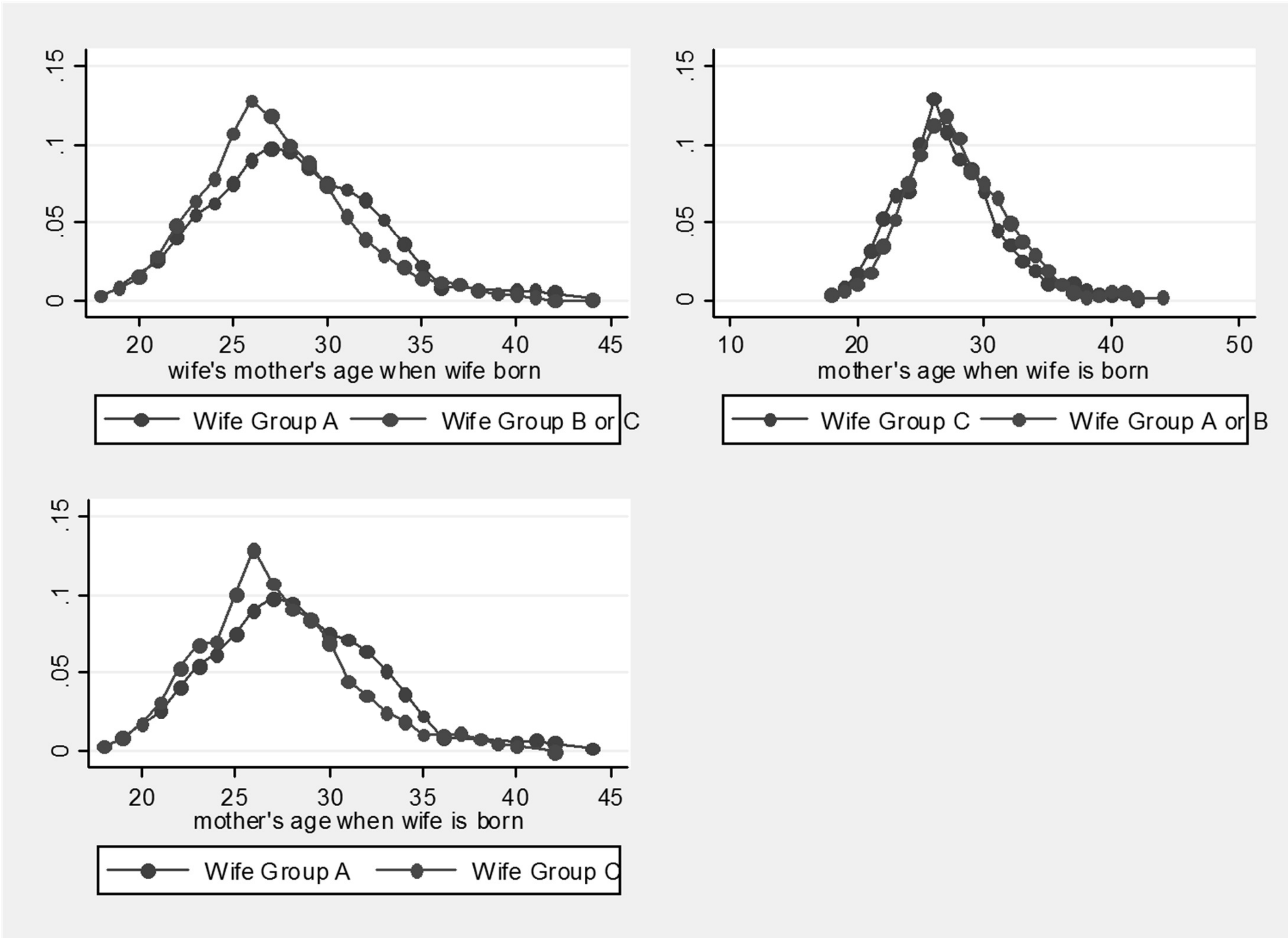

Figure 6.2. Kernel Density Distribution of the Wife's Mother's Age at Wife's Birth. *Note*: Japanese Panel Survey of Consumers 1993-2003, Based on the Author's Calculations.

The Stackelberg model predicts that the husband's childhood environment, his family's socio-economic condition and family composition affect his perception of how much men should perform housework based on gender norms (Z^e_{ht-1}). This is expected to be positively related to the amount of housework he performs. The results from the IV Probit indicate that the prefecture in which the husband grew up has an effect on his contribution to housework, which confirms that his attitudes and behavior towards housework is affected by his perception of gender norms prevalent in the areas in which he grew up. For example, men who grew up in the northern island of Hokkaido perform less housework for both B and C. Men from the southeastern island of Shikoku for A, and the southern island of Kyushu for C also contribute less housework. Hence, men who grew up in areas far away from Tokyo, Osaka and Chugoku are likely to possess more traditional attitudes towards gender roles depicted by a lower (Z^e_{ht-1}), consequently reducing his time to housework.

The family composition affects one's behavior towards housework too. For B, if the husband is not the firstborn son, the more siblings he has, the less he contributes to housework. This is not surprising since men who are not firstborn sons are often considered to be less responsible and if he has more siblings, he may not have had to do much housework in his upbringing. For C, the husband contributes more when his wife is not a firstborn daughter and the more siblings she has. This indirectly confirms Holloway and Behrens' (2002) study that firstborn girls are expected to be more responsible than their younger siblings, whereas a non-firstborn daughter with siblings may not have had to perform housework. Consequently, husbands married to non-firstborn daughters may have to contribute more.

From the theoretical model, it was anticipated that those living in a more tightly knit community such as in non-metropolitan areas, may have a negative effect on the husband's contribution to housework because there is pressure to conform to the norms (indicated by α). However, the dummy variable for the couple living in a metropolitan city is not significant for all three cases. It should be noted, nevertheless, that the dummy variable for living in a metropolitan area may not adequately capture how tight knitted the community in which the couple lives where there are stronger pressure to conform to social norms.

For couples with two children (group C), the husband performs more housework when the wife is younger shown by the positive coefficient on the year the wife is born. This likely reflects the life cycle of the wife since the couple is more likely to have younger children when the wife is younger for C, eliciting support from the husband. For A and B, the year the wife is born is not significant. As discussed in the previous chapter, for a larger percentage of couples in C, it has been 8 years or more since the last child is born, than for B. The reason why the year the woman is born is significant for C, but insignificant for A and B could be because their youngest child for C on average is older than B, and the year the wife is born is a driving factor for C, whereas for A and B, the year born is not a driving factor in fertility decisions because they don't have children for A and their youngest child is younger for B.

The wife's age at first birth is positively correlated with the contribution from the husband for B and C suggesting that women entered into motherhood at an older age is more likely to receive support from their husbands. This could arise because women who had their first child later in life (for B and C) are more likely to have helpful husbands, or because they are more likely to have younger children. Age at marriage has no effect on the husband's contribution for A.

For C, living with the husband's mother at *t-2* reduces the husband's unpaid work, while living with the wife's mother at *t-2* has no effect on the husband's contribution to housework. This suggests that the husband's mother living in the household allows the husband to reduce his contribution in housework, but this is not the case if the couple lives with the wife's mother. Which mother cohabits with the couple seems to have a differential impact on the husband's contribution to housework suggesting that it could affect the dynamics between the spouses. From the husband's perspectives, living with his mother-in-law may prevent him from slacking off on household responsibilities, as is the case if he lived with his own mother.

The log of the husband's government transfers at *t-2* has a positive effect on the husband's time spent in domestic work for B and C.[62] As discussed in section 5.2.3, child allowance is provided to low and middle income families with young children. Hence, this could be explained by: (a) the husband taking on more household responsibilities when he has a younger child; or (b) the husband of low or middle-income

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62. This is excluded for A because the instances of non-zero cases are rare. The government transfers are mostly related to child allowance and instances of unemployed men are rear. 99.0% of husbands in the sample had jobs at *t-2* and therefore are unlikely to have received unemployment benefits at *t-2*.

family performs more housework. However, since we control for the husband's annual labor and property income (which do not show significant effects on housework[63]), we expect the positive effects of government transfers on the husbands' housework to be related to the age of the youngest child. In other words, the younger the youngest child, the more housework the husband performs.

Educational attainment affects the husband's contribution to housework for couples with one child (group B). Husbands who are junior college or technical school graduates, or university graduates take on less household responsibilities than men who are middle school or high school graduates (i.e. the reference category). This could be because education increases the husband's offered wage creating a substitution effect away from unpaid work. In contrast, for couples with no children (A), husbands who are university graduates contribute more to housework than the reference category.[64] For this group, income effect seems to dominate the substitution effect. In other words, the higher the wage, the person does not need to spend as much time in the workforce to obtain the same level of income, leading him to spend less hours in paid work and possibly more in unpaid work. For couples with two children (C), education does not affect the husband's time spent in housework.

Contribution to unpaid work is higher for men married to women who are university graduates, junior college or technical school graduates, than those married to junior or senior high school graduate women for B. Women university graduates and junior college or technical school graduates in B were less likely to have had a job at *t-2* than high school graduates which is consistent with findings from other studies (Ministry of Health, Labour and Welfare 2008a, Yamashita 1999). This implies that husbands who are married to university graduate women would spend less time on housework. On the other hand, a higher percent of university graduate women in the labor force work in regular staff positions than high school graduates, and regular staff jobs tend to require working long hours (Ministry of Health, Labour and Welfare 2008a). This implies that the husbands married to more educated women would perform more housework. Hence the positive effect of the wife's education on the husband's housework seems have

63. In fact the correlation coefficient between the husband's labor income and government transfers is negative as expected but small at -0.125.

64. This is consistent with the findings in Australia, Israel and U.S. (Floro and Miles 2003, Gronau 1977 and Bianchi, Milkie, Sayer and Robinson 2000).

outweighed the negative effect. For C, the positive effect of the wife's education on the husband's housework seems to have canceled out the negative effect as it has no effect on the husband's contribution to housework.

6.2 Predicting Fertility: Pooled IV Probit

The average marginal effects predicting the first, second and third births are presented in table 6.2. For each group, two sets of results are presented: (a) a pooled Probit model using observed log of the husband's time in housework at *t-2*; and (b) the pooled IV probit model using predicted log of time in housework at *t-2* from the first stage. The former does not control for the endogeneity of the husband's time in housework, while the latter does so by using instrument variables. In the next section, we discuss the probabilities of each birth in turn. The cluster standard errors calculated from the marginal effects are shown in the brackets. The wald test of exogeneity shows that the correlation coefficient between the error terms of the first and second stage u_{it} and ε_{it-2} are independent for A and C. The correlation coefficient for B is –0.833 and is significant at 10 percent for B. This means that the unobserved characteristics and shocks at *t-2* that are correlated with the husbands to work longer at domestic chores and childcare are likely to have a negative effect on unobservable characteristics for fertility at *t*.

6.2.1 Group A: Predicting the Birth of the First Child

The husband's time in housework does not affect the probability of having the first child as shown in the Probit in Table 6.2. This contradicts our hypothesis that the more the husband contributes, the higher the wife's higher birth probability. Further, in the IV Probit model, a 10 percent increase in the log of the husband's time actually reduces the birth probability by 2.8 percent and this is marginally significant at 10 percent. The result suggests that women decide to have their first child even when their husbands are not helpful. Since we use a log of the time spent plus one minute, a 10 percent increase in the log of the time spent in housework plus one from the average amounts to 25.2 minutes of housework. Hence a man increasing his housework contribution by 25.2 minutes could reduce the first birth probability by 2.8 percent. While 25.2 minutes seem small to cause such a reduction in birth probability, this figure represents about 50 percent of the time Group A's men spent in housework. As seen in the descriptive statistics in

Table 6.2. IV Probit: Predicting First, Second, and Third Births

	Group A first baby born		Group B second baby born		Group C third baby born	
	Probit	IV probit	Probit	IV probit	Probit	IV probit
Endogenous Variable						
Observed log of husband’s time in housework at t-2	0.000615		0.0119**		-0.000577	
	(0.00716)		(0.00481)		(0.00173)	
Predicted log of husband’s time in housework at t-2		-0.276*		0.366***		0.115
		(0.167)		(0.109)		(0.329)
Individual and household characteristics						
Wife’s year born	0.0308***	0.134***	0.0273***	0.0769*	0.0101***	0.0952
	(0.00953)	(0.0512)	(0.00390)	(0.0398)	(0.00161)	(0.0992)
Wife’s age at first birth			0.00675	-0.000831	0.000847	-0.0134
			(0.00423)	(0.0261)	(0.00209)	(0.0690)
Wife’s age at marriage	0.0252**	0.116**				
	(0.00986)	(0.0513)				
Lived with wife’s mother at t-2	-0.0125	-0.0415	0.0122	0.0400	0.0124	0.143
	(0.0896)	(0.449)	(0.0429)	(0.225)	(0.0125)	(0.166)
Lived with husband’s mother at t-2	-0.0560	-0.304	-0.00414	0.113	0.0255***	0.367***
	(0.0527)	(0.211)	(0.0266)	(0.134)	(0.00913)	(0.140)
Lived in metropolitan at t-2	-0.0822**	-0.246	0.00907	0.0796	0.00795	0.0988
	(0.0407)	(0.247)	(0.0227)	(0.109)	(0.0100)	(0.127)
Log husband’s annual labor earnings at t-2	0.00538	0.000178	0.00380	-0.00370	0.00304	0.0360
	(0.00970)	(0.0441)	(0.00925)	(0.0358)	(0.00327)	(0.0395)
Log husband’s annual property earnings at t-2	0.00299	-0.00398	0.000753	-0.00557	-0.000125	-0.00450
	(0.00490)	(0.0275)	(0.00305)	(0.0137)	(0.00131)	(0.0176)
Log of husband’s annual state transfers at t-2			0.00602***	0.0104	0.00109	0.0107
			(0.00210)	(0.0133)	(0.000743)	(0.0132)
Wife’s years of work experience before marriage	0.0127	0.0353	-0.00294	-0.0242	0.00791*	0.0908
	(0.0196)	(0.0914)	(0.00980)	(0.0508)	(0.00414)	(0.0620)

Table 6.2 continued

	Group A first baby born		Group B second baby born		Group C third baby born	
	Probit	IV probit	Probit	IV probit	Probit	IV probit
Wife's years of work experience before marriage sq.	-0.00152	-0.00516	0.000753	0.00230	-0.000322	-0.00329
	(0.00175)	(0.00839)	(0.00112)	(0.00577)	(0.000444)	(0.00613)
First child is a girl * husband is firstborn son			0.00581	-0.0830		
			(0.0210)	(0.111)		
Wife is 2 years or more older than husband	-0.0946	-0.261	0.00428	-0.164	0.0299	0.371
	(0.0624)	(0.337)	(0.0409)	(0.194)	(0.0233)	(0.298)
Husband is 10 years or more older than wife	-0.144*	-0.593*	-0.0676	-0.414*	0.0138	0.176
	(0.0822)	(0.339)	(0.0499)	(0.235)	(0.0203)	(0.246)
Education[a]						
Wife a university grad	0.0295	0.158	0.0145	-0.126	0.0184	0.193
	(0.0561)	(0.239)	(0.0322)	(0.166)	(0.0160)	(0.241)
Husband a university grad	0.0159	0.307	0.0324	0.268**	-0.0216*	-0.270*
	(0.0434)	(0.216)	(0.0240)	(0.117)	(0.0112)	(0.140)
Wife a technical school, junior college	0.0318	0.0408	-0.0194	-0.193*	0.0199**	0.231
	(0.0406)	(0.198)	(0.0233)	(0.112)	(0.00933)	(0.141)
Husband a technical school, junior college grad	-0.0183	-0.0806	0.0202	0.329**	-0.0198*	-0.237
	(0.0568)	(0.247)	(0.0282)	(0.157)	(0.0114)	(0.150)
Husband's father a university grad	0.0293	0.0246	-0.0184	-0.168	0.00969	0.0826
	(0.0470)	(0.233)	(0.0283)	(0.125)	(0.0125)	(0.200)
Husband's father a technical school, junior college Graduate	0.0255	-0.0507	-0.0742	-0.330	-0.0403	-0.477
	(0.0780)	(0.365)	(0.0561)	(0.218)	(0.0328)	(0.439)
Family background						
Husband went to private high school	0.0622	0.176	-0.0591***	-0.287***	-0.00386	-0.0462
	(0.0410)	(0.225)	(0.0213)	(0.108)	(0.00966)	(0.119)
Husband non firstborn son * number of siblings	0.00267	-0.0150	-0.0122	0.0191	-0.00127	-0.0299
	(0.0268)	(0.112)	(0.0109)	(0.0606)	(0.00473)	(0.0625)

Table 6.2 continued

	Group A first baby born		Group B second baby born		Group C third baby born	
	Probit	IV probit	Probit	IV probit	Probit	IV probit
Wife non-first born daughter * number of siblings	0.0269	0.151	-0.0272**	-0.0955	-0.00339	-0.0614
	(0.0268)	(0.115)	(0.0136)	(0.0670)	(0.00453)	(0.0693)
Husband is firstborn son * wife is firstborn daughter	-0.0232	-0.145	-0.0513*	-0.0982	-0.0165	-0.265
	(0.0575)	(0.242)	(0.0283)	(0.154)	(0.0122)	(0.186)
Region in which husband grew up during primary and junior high school [b]						
Husband grew up in Hokkaido	0.0593	0.0814	-0.000708	0.188	0.0332*	0.499*
	(0.0704)	(0.350)	(0.0417)	(0.215)	(0.0197)	(0.274)
Husband grew up in Touhoku	0.140*	0.506	0.0171	-0.000230	-0.00415	-0.00189
	(0.0796)	(0.371)	(0.0358)	(0.160)	(0.0140)	(0.217)
Husband grew up in Kita-kanto	-0.0277	-0.247	-0.0228	-0.0731	-0.0112	-0.154
	(0.125)	(0.479)	(0.0522)	(0.261)	(0.0173)	(0.216)
Husband grew up in Tokai	0.0118	0.405	0.0707	0.312	0.0505**	0.592*
	(0.0952)	(0.426)	(0.0649)	(0.243)	(0.0214)	(0.333)
Husband grew up in Chubu	0.0588	0.155	0.0143	0.185	0.00847	0.112
	(0.0470)	(0.218)	(0.0245)	(0.132)	(0.0105)	(0.130)
Husband grew up in Shikoku	0.0100	-0.877	0.00365	0.0767	-0.000606	0.0257
	(0.0920)	(0.643)	(0.0497)	(0.270)	(0.0233)	(0.301)
Husband grew up in Kyushuu			-0.0414	-0.173	0.0103	0.197
			(0.0298)	(0.132)	(0.0117)	(0.227)
Husband grew up in Okinawa			0.139*	0.305	0.0479*	0.628*
			(0.0769)	(0.349)	(0.0263)	(0.350)
Husband grew up in Kyushuu or Okinawa [c]	0.0639	0.128				
	(0.0619)	(0.303)				
Observations	548	548	1,381	1,381	2,990	2,990
Log-pseudolikelihood	-252.94867	-1,380.6896	-549.94355	-3,513.5391	-450.46874	-6,832.4602
Wald test of exogeneity: correlation coefficient between u_{it} and ε_{it-2}		0.664		-0.833*		-0.256
Correctly predicted	82.66%	78.47%	83.42%	78.93%	95.83%	95.89%

Note: Dependent Variable: Baby born in last 12 months. Average marginal effects reported. Cluster standard errors in parentheses. Yearly dummies included.

[a] Shows highest educational attainment. Reference category for wife is middle school and high school graduates, and for husband is middle school and high school graduates.

[b] The prefecture in which the husband grow up the longest during primary and junior high school. Reference category is Metropolitan Tokyo area (Shutoken) and Metropolitan Osaka area (Kansai area) and Chugoku.

[c] For group A, husbands who grew up in Okinawa is grouped with those that grew up in Kyushu because of the number of observations is small.

*** significant at 1%, ** significant at 5 %, * significant at 10%.

Table 5.1.2, men in Group A only spent 49.4 minutes of housework on a non-workday. The spike in housework men perform occurs only when the first child is born. Therefore, men in Group A would have to increase their housework contribution by 50 percent to cause a reduction in birth probability. Table 5.1.2 also shows that men married to women who had their first child at *t* only spent 40.3 minutes in housework on a non-workday at *t-2* compared to 51.4 minutes for men who didn't have a child at *t*. For either group, regardless of whether they had a child or not, men spent little time in housework and the difference on average is only about 11 minutes. Therefore, women seem to have their first child regardless of whether their husbands are helpful or not since men without children spend little time in housework to begin with.

Younger wives (i.e. the higher the year born) have a higher first birth probability, all else equal. Each year difference increases the likelihood of having the first child by 13.4 percent in the IV Probit model. Age at marriage also raises the birth probability by 11.6 percent for each year a woman delays entering into matrimony. The marginal effects of the year the wife is born and age at marriage are smaller for the Probit which are 3.1 percent and 2.5 percent, respectively. Older women are less likely to have a first child either because they do not want children or because they are likely to face a lower fecundity. But women who married later in life face a higher likelihood of having their first child.

Women married to men ten years or older than his wife face a 59.3 percent lower birth probability. This could be because older men do not want to face the physical burden of childcare or because of increased risks in pregnancy associated with older paternal age (Fisch 2005).

Contrary to expectations, growing up in different regions does not have an effect on the birth probability. Therefore factors that affect the first birth probability are mostly related to the women's life cycle and to some extent, her husband's life cycle. But regional factors, education, family wealth, background and current income do not seem to have a significant effect.

6.2.2 Group B: Predicting the Birth of the Second Child

We find that the husband's contribution to housework at *t-2* has a positive effect on having a second child at *t*. A 10 percent increase in the log of the husband's time in housework increases the probability of childbearing by 0.12 percentage point and is significant at 5 percent in the Probit model.

When we use the IV Probit model, the magnitude of the (predicted) husband's time in housework on fertility becomes larger. A 10 percent increase in the log of the husband's time in housework increases fertility probability by 3.7 percent and is significant at 1 percent. The results confirm our hypothesis that that the husband's time in housework increases the probability of having a second child, and the magnitude of the effect become larger when we control for the endogeneity. But the IV estimation shows larger standard errors giving less precise estimates. Nevertheless, this suggests that there is a downward bias in the husband's contribution to housework in the Probit estimations compared to the IV Probit model. In other words, the unobserved characteristics that cause an increase in the husband's time in housework actually reduce the likelihood of childbearing. All else constant, men who spend more time in domestic chores and childcare prefer to have fewer children.[65] This could be because men who allocate more time in housework do not want to have another child because they may consider it to be a burden themselves.

What does a 10 percent increase in husband's time in housework represent? In Table 5.1.2, the husbands in B spent on average 176.1 minutes in housework and childcare on a non-workday at *t-2.* In the IV Probit, a 10 percent increase in the log of the time spent plus one translates to a 120.12 minutes increase. In other words, if a man increases his time spent on housework and childcare by 120.12 minutes on a non-workday, he and his wife will face a 3.7 percent higher birth probability in the subsequent period.

Looking at other factors affecting fertility, the year the wife is born is significant in both models. The younger the wife (i.e. the higher the year born), the higher the birth probability, and each birth year increases the likelihood by 2.7 percentage in the Probit. The percentage is larger when we control for heterogeneity in the IV Probit model where the marginal effect for the wife's year born is 7.7 percent. This shows the importance of the women's life cycle in determining fertility. However, the age at first birth does not appear to be a significant factor in the second birth probability.

Men who are graduates of private high schools as a proxy for family wealth have a 5.9 percent lower birth probability in the Probit model. The magnitude also becomes larger in the IV Probit model where it reduces the birth probability by 28.7 percentage point. All else equal, the family wealth effect

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65. This result could be anticipated from the fact that the correlation coefficient between u_{it} and ε_{it-2} is negative.

appears to reduce the likelihood of having a second child and couples stop having children after one child. Previous literature has attempted to explain the inverse relationship between wealth (or income) and fertility in developed countries by arguing that as wealth increases, households demand quality over quantity of children (Becker 1991, Hotz *et al* 1997). However, the husband's labor earnings, property income or government transfers which are also indicators of wealth and income are insignificant in the IV Probit model.

Husbands who are more educated face a higher birth probability. Men who are university graduates have a 26.8 percent higher birth in the IV Probit model. All else equal, a more educated husband is likely to have a stable job and this could explain the positive effect on fertility. While current income does not affect childbearing, expected future income may have a positive effect on second birth probability.

As we saw in the first birth probability, when the husband is 10 years or older than his wife, the couple faces a lower birth probability of 41.4 percent in the IV Probit. Therefore we find that women married to older men are less likely to have their first and second child.

In addition to life cycle factors, family wealth and the husband's education affect the second birth probability. However, consistent with A, current income, the wife's education and regional factors are not significant factors in predicting fertility in B.

6.2.3 Group C: Predicting the Birth of the Third Child

The results from the Pooled Probit and IV Probit models show that the husband's time in housework does not have any significant effect on the probability of having a third child. Hence, we find that the husband's contribution to housework only affects the probability of having a second child, but it does not affect the probability of having the first or third child. This suggests that the wife gains information about the husband's helpfulness after the birth of the first child. The results also indicate that the unhelpful husbands were already weeded out before the transition into the second birth, explaining why time in housework is not significant for the third birth probability. In other words, they did not enter into two child couples (B) to begin with.

Looking at other factors predicting the birth of the third child, the year the woman is born is insignificant in the IV Probit model. Further, the age at first birth is insignificant in both models, consistent with the earlier findings in the second birth probability.

In the Probit model, living with the husband's mother at *t-2* increases birth probability by 2.6 percent, and the effect becomes larger at 36.7 percent in the IV Probit model.

The proxy variables for family wealth such as the father's education or whether the husband went to a private senior high school are not significant in predicting the third birth, unlike for the second birth. This could indicate those who had more family wealth stopped having children at one child, and therefore they did not transition into group C.

Women's education is insignificant consistent with our findings in estimating the first and second birth probabilities.

The husband who has a university degree reduces the third birth probability by 27 percent suggesting that when the husband is more educated, the couples are more likely to have two children, but are less likely to have a third child.

Regional factors affect the third birth probabilities. Men who grew up in Hokkaido have a 49.9 percent higher probability, while men who grew up in Okinawa face a 62.8 percent higher birth probability.

In summary, we find that the husband's time spent in housework only has a positive effect on the second birth probability but no effect on the first and third births. It suggests that the husband's time spent in housework before the first child is born is not a good indicator of how helpful the husband is going to be in childcare. But his contribution to housework and childcare after the first child is born is a good indicator of how helpful he is going to be after the second child is born. Women's life cycle factors, namely the year she is born, affect fertility but the age at first birth does not impact on the second and third birth probabilities. Family wealth has an inverse relationship only with the second birth probability which is consistent with findings in developed countries. However, we find no effects of current labor and property earnings and government transfers on fertility. The husband's education has a positive effect on the second birth probability, but a negative effect on the third birth.

6.3 Results from the Second Approach: Duration Model

We review the results from the first stage of the duration model in 6.3.1 and analyze whether the husband's time in housework affects the timing of birth in section 6.3.2.

6.3.1 First Stage of Duration Model: Husband's Time in Housework

Table 6.3 presents the first stage of the duration model estimating the husband's time in housework on a non-workday at *t-2*. The first column of each group shows the pooled OLS estimates allowing for the standard errors to be correlated by household. The second column of each group shows the pooled maximum likelihood estimation using maximum likelihood (ML) standard errors shown in equation (5.5.14)', but repeated observations by household are treated as independent because the Murphy Topel standard errors (for the second stage of the duration model) are not available with cluster standard errors. Note that the OLS coefficients are equivalent to maximum likelihood coefficients, and the only difference between the two columns is the standard errors (Greene 2003). We expect the OLS standard errors to be larger than ML standard errors because the sum of squared residuals is divided by the number of observations for the ML (as shown in equation 5.5.14'), but for the OLS, the sum of the squared residuals is divided by the number of observations minus the number of explanatory variables plus a constant (Greene 2003). Consequently, the denominator of the OLS standard errors is smaller than that of the ML standard errors. In addition, clustering the standard errors by household is expected to increase the variance especially for time invariant variables where the intra-household correlation over the sample period is one (Cameron and Trivedi 2009).

As predicted, the cluster standard errors are larger than the ML standard errors without the clustering by household.

We exclude the year the wife is born because it is highly collinear with the duration variables. When the wife is older (i.e. the lower the year born), it is likely that the duration of marriage or the duration since last birth is longer. The woman's life cycle is taken into account by including the age at marriage or age at first birth.

Table 6.3. Pooled Linear Regression: First Stage of Duration Model

	Group A		Group B		Group C	
	OLS coefficient	Maximum likelihood	OLS coefficient	Maximum likelihood	OLS coefficient	Maximum likelihood
	(Cluster standard errors)	(ML standard errors)	(Cluster standard errors)	(ML standard errors)	(Cluster standard errors)	(ML standard errors)
<u>Instruments</u>						
Husband's mother age 25-30 at birth	0.252	0.252	-0.249	-0.249**	0.273*	0.273***
	(0.323)	(0.212)	(0.186)	(0.115)	(0.152)	(0.083)
Wife and Husband's mothers 31+ at birth	1.610***	1.610***	-1.026**	-1.026***	-0.532	-0.532**
	(0.613)	(0.525)	(0.525)	(0.288)	(0.491)	(0.210)
<u>Duration Variables</u>						
Duration of marriage 0-4 at *t*	0.0246	0.0246				
	(0.461)	(0.382)				
Duration of marriage 5-8 at *t*	0.118	0.118				
	(0.383)	(0.315)				
1 year before first child born at *t-2* (or 1 year since first birth at *t)*			-1.516***	-1.516***		
			(0.303)	(0.218)		
1 year before first child born at *t-2* (or 2-7 years since first birth at *t)*			1.100***	1.100***		
			(0.238)	(0.1577)		
1 year before second child born at *t-2* (or 1 year since second birth at *t)*					0.714***	0.714***
					(0.173)	(0.154)
Second child is age 0-2 at *t-2 (*or 2-4 years since second birth at *t)*					0.896***	0.896***
					(0.121)	(0.106)
<u>Individual and household characteristics</u>						
Wife's age at marriage	0.0446	0.0446				
	(0.0693)	(0.046)				

Table 6.3 continued

	Group A		Group B		Group C	
	OLS coefficient	Maximum likelihood	OLS coefficient	Maximum likelihood	OLS coefficient	Maximum likelihood
	(Cluster standard errors)	(ML standard errors)	(Cluster standard errors)	(ML standard errors)	(Cluster standard errors)	(ML standard errors)
Wife's age at first birth			0.0423	0.0423	0.122***	0.122***
			(0.0308)	(0.0217)	(0.0348)	(0.0199)
Lived with wife's mother at t-2	-0.238	-0.238	0.124	0.124	-0.145	-0.145
	(0.833)	(0.698)	(0.424)	(0.250)	(0.262)	(0.1450)
Lived with husband's mother at t-2	-0.431	-0.431	-0.435*	-0.435***	-0.555***	-0.555***
	(0.406)	(0.296)	(0.247)	(0.143)	(0.190)	(0.0946)
Lived in metropolitan at t-2	0.153	0.153	-0.200	-0.200	-0.145	-0.145
	(0.301)	(0.219)	(0.216)	(0.143)	(0.191)	(0.10176)
Log husband's annual labor earnings at t-2	-0.0459	-0.0459	0.0445	0.0445	-0.0302	-0.0302
	(0.0750)	(0.0761)	(0.0460)	(0.0490)	(0.0458)	(0.039)
Log husband's annual property earnings at t-2	-0.0571	-0.0571**	0.00325	0.00325	0.0187	0.0187
	(0.0426)	(0.0289)	(0.0227)	(0.0174)	(0.0165)	(0.0138)
Log of husband's annual state transfers at t-2			0.00590	0.00590	0.0396***	0.0396***
			(0.0144)	(0.0130)	(0.0106)	(0.0102)
Wife's years of work experience before marriage	-0.102	-0.102	-0.0366	-0.0366	-0.0434	-0.0434
	(0.106)	(0.0876)	(0.0854)	(0.0493)	(0.0830)	(0.0423)
Wife's years of work experience before marriage squared	0.00541	0.00541	0.00477	0.00477	-0.00182	-0.00182
	(0.00927)	(0.0078)	(0.00876)	(0.00496)	(0.00998)	(0.0045)
First child is a girl * husband is firstborn son			0.326*	0.326*		
			(0.180)	(0.1242)		
Wife is 2 years or more older than husband	0.494	0.494	0.569*	0.569*	0.137	0.137
	(0.624)	(0.425)	(0.320)	(0.2503)	(0.510)	(0.262)
Husband is 10 years or more older than wife	-0.0293	-0.0293	0.385	0.385	0.202	0.202
	(0.680)	(0.680)	(0.434)	(0.2798)	(0.2798)	(0.2529)

Table 6.3 continued

	Group A		Group B		Group C	
	OLS coefficient	Maximum likelihood	OLS coefficient	Maximum likelihood	OLS coefficient	Maximum likelihood
	(Cluster standard errors)	(ML standard errors)	(Cluster standard errors)	(ML standard errors)	(Cluster standard errors)	(ML standard errors)
Education[a]						
Wife a university grad	0.119	0.119	0.357	0.357*	0.0417	0.0417
	(0.487)	(0.319)	(0.273)	(0.1890)	(0.265)	(0.165)
Husband a university grad	0.906**	0.906***	-0.378*	-0.378***	-0.0137	-0.0137
	(0.369)	(0.273)	(0.204)	(0.136)	(0.202)	(0.105)
Wife a technical school, junior college	-0.390	-0.390	0.401**	0.401***	0.0199	0.0199
	(0.358)	(0.248)	(0.197)	(0.131)	(0.181)	(0.097)
Husband a technical school, junior college grad	-0.0313	-0.0313	-0.680**	-0.680***	-0.00837	-0.00837
	(0.432)	(0.432)	(0.322)	(0.1683)	(0.222)	(0.123)
Husband's father a university grad	-0.297	-0.297	0.358	0.358**	0.353	0.353**
	(0.446)	(0.271)	(0.221)	(0.159)	(0.230)	(0.140)
Husband's father a technical school, junior college grad	-0.558	-0.558	0.136	0.136	-0.232	-0.232
	(0.905)	(0.510)	(0.278)	(0.278)	(0.270)	(0.241)
Family background						
Husband went to private high school[b]			0.209	0.209	0.0511	0.0511
			(0.185)	(0.1190)	(0.189)	(0.0953)
Husband non firstborn son * number of siblings	-0.122	-0.122	-0.143*	-0.143*	0.119	0.119**
	(0.332)	(0.179)	(0.0751)	(0.0557)	(0.0985)	(0.0985)
Wife non-first born daughter * number of siblings	0.178	0.178	0.00821	0.00821	0.149*	0.149***
	(0.261)	(0.166)	(0.106)	(0.0692)	(0.0876)	(0.0485)
Husband is firstborn son * wife is firstborn daughter	-0.204	-0.204	-0.252	-0.252	0.555**	0.555***
	(0.577)	(0.363)	(0.249)	(0.249)	(0.237)	(0.122)

Table 6.3 continued

	Group A		Group B		Group C	
	OLS coefficient	Maximum likelihood	OLS coefficient	Maximum likelihood	OLS coefficient	Maximum likelihood
	(Cluster standard errors)	(ML standard errors)	(Cluster standard errors)	(ML standard errors)	(Cluster standard errors)	(ML standard errors)
<u>Region in which husband grew up during primary and junior high school</u> [c]						
Husband grew up in Hokkaido	-0.575	-0.575	-0.710**	-0.710***	-0.881**	-0.881***
	(0.613)	(0.395)	(0.329)	(0.225)	(0.356)	(0.186)
Husband grew up in Touhoku	-0.0395	-0.0395	0.106	0.106	-0.309	-0.309**
	(0.464)	(0.546)	(0.309)	(0.221)	(0.327)	(0.154)
Husband grew up in Kita-kanto	-0.440	-0.440	-0.0245	-0.0245	-0.00706	-0.00706
	(0.561)	(0.508)	(0.444)	(0.243)	(0.384)	(0.17065)
Husband grew up in Tokai	1.422	1.422***	-0.240	-0.240	0.385	0.385
	(0.963)	(0.545)	(0.311)	(0.382)	(0.516)	(0.276)
Husband grew up in Chubu	-0.157	-0.157	-0.455*	-0.455***	-0.0237	-0.0237
	(0.428)	(0.287)	(0.257)	(0.155)	(0.209)	(0.114)
Husband grew up in Shikoku	-3.063***	-3.063***	-0.0709	-0.0709	-0.0281	-0.0281
	(0.689)	(1.132)	(0.582)	(0.284)	(0.458)	(0.212)
Husband grew up in Kyushuu or Okinawa[d]	-0.553	-0.553				
	(0.434)	(0.346)				
Husband grew up in Kyushuu			0.0174	0.0174	-0.606**	-0.606***
			(0.251)	(0.171)	(0.256)	(0.133)
Husband grew up in Okinawa			1.421**	1.421**	-0.147	-0.147
			(0.708)	(0.697)	(0.379)	(0.546)
Constant	1.654	1.654	2.030*	2.030***	0.821	0.821
	(2.152)	(1.663)	(1.178)	(0.9204)	(1.045)	(0.754)
Observations	548	548	1,381	1,381	2,990	2,990
R-squared	0.142	0.142	0.267	0.267	0.142	0.142

Table 6.3 continued

	Group A		Group B		Group C	
	OLS coefficient	Maximum likelihood	OLS coefficient	Maximum likelihood	OLS coefficient	Maximum likelihood
	(Cluster standard errors)	(ML standard errors)	(Cluster standard errors)	(ML standard errors)	(Cluster standard errors)	(ML standard errors)
<u>Tests from IV Reg</u>						
Kleibergen-Paap LM rank statistic (Under-identification test)	4.979*	9.485***	5.041*	14.704***	2.52*	20.281***
Hansen J statistic (over-identification of all instruments)	0.206		2.690		0.168	
Sargan statistic (over-identification of all instruments)		0.218		3.514*		0.176
F statistic	3.46**	4.47**	2.64*	7.19***	4.935*	10.06***

Note: Dependent Variable: Log of husband's Time in Housework and Childcare on Non-workday at *t-2*. Yearly dummies included.

[a] Shows highest educational attainment. Reference category for wife is middle school and high school graduates, and for husband is middle school and high school graduates.

[b] For group A, this variable is excluded because it causes multicollinearity problems.

[c] Indicates the region in which the husband grew up the longest during primary and junior high school. Reference category is Metropolitan Tokyo area (Shutoken), Metropolitan Osaka area (Kansai area) and Chugoku.

[d] For group A, husbands who grew up in Okinawa is grouped with men that grew up in Kyushu because of the number of observations is small.

*** significant at 1%, ** significant at 5 %, * significant at 10%.

The instruments are jointly significant using the F-statistic but the F-statistic is only significant at 10 percent for B and C when we use the OLS cluster standard errors. Further, the instrument the husband's mother was age 26-30 at his birth is only significant at 10 percent for C. Hence, we suspect that the presence of weak instruments and we have to interpret these results with caution.

Following convention, the tests of over-identification restriction and under-identification are conducted assuming a linear probability model, in other words with an IV regression. The Kleibergen-Paap LM rank test of under-identification test shows that the matrix of coefficients is identified. The Hansen J-statistic for the OLS estimates indicates that the instruments are valid. However, the Sargan test for over-identification of instruments fails for group B in the ML estimation, hence we have to exercise caution in interpreting the results for B.

Marriage duration (0-4 years, 5-8 years) has no effect on the husband's time in housework for couples without children (A). For couples with one child (group B), we create a dummy variable indicating one year since first birth at time *t* which is necessary for assessing the impact of duration since last birth on fertility at *t*. This variable is equivalent to one year *before* the first birth at time *t-2*. Therefore including this variable in the first stage estimation is equivalent to assessing the impact of one year before the first birth on husband's time in housework at *t-2*. Even though this variable does not belong in the first stage equation, it is necessary to include it for identification purposes (Wooldridge 2002).[66] As we saw from the descriptive statistics in section 6.2, the spike in the husband's contribution to housework occurs when the first child is born. Therefore, as expected, a year before the first child is born at *t-2* has a significantly negative effect on housework at *t-2*. The child being 0-5 years old at *t-2* has a positive effect on husband's time in housework for group B. For couples with two children (C), we find a year before the second child is born and the second child being ages 0-2 at *t-2* has a positive effect on the husband's time in housework at *t-2.* In summary, we find that: a) marriage duration has no effect on time in housework; b) the birth of first child causes a hike in the husband's contribution; and c) the younger the youngest child, the higher the husband's contribution to housework.

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66. Wooldridge (2002) calls the first stage estimation a reduced form equation.

Age at marriage has no effect on the husband's unpaid work for A. Similarly, the age at first birth is insignificant for B. In contrast, the age at first birth has a positive effect on time spent in housework for C. This suggests that women who had their first child later in life are married to more helpful husbands.

For B and C, husbands contribute less to housework if the couple lived with the husband's mother at *t-2*, while living with the wife's mother has no effect. This is consistent with our findings from the first stage of the IV Probit model for C. When the woman is 2 years older or more than the husband, his contribution to housework is higher for B.

When the husband is a university graduate, he performs more housework when the couple has no children (A), but he contributes less to housework when the couple has one child (B). Husbands of more educated wives (technical school or junior college graduates) also take on more unpaid work for B. Women who are more educated are more likely to withdraw from the labor force when the first child is born and less likely to return to the workforce. This is expected to have a negative effect on the husband's unpaid work. But more educated women who are in the labor force are more likely to work longer hours causing a possibly a positive effect on the husband's time in housework. Therefore, the positive effect seems to have outweighed the negative effect for B. But we see no effect of the wife's education on husband's unpaid work for C, hence the negative effect cancels out the positive effect.

When the husband is not a firstborn son, the more siblings he has, the less housework he performs for B. As discussed earlier, this is not surprising since men who are not firstborn sons are considered to be less responsible and with more siblings, he may not have been required to help out in the house. Conversely, if the wife is not a firstborn daughter, the more siblings she has, the more the husband has to contribute to unpaid work for C.

Regional factors have an effect on housework. Men who grew up in the northern island of Hokkaido contribute less to housework for B and C. Similarly, men who grew up in the southeastern island of Shikoku and the southern island of Kyushuu perform less unpaid work for A and C, respectively. Hence, as expected, men from areas away from the large Metropolitan areas tend to have more traditional attitudes towards gender roles. In contrast, husbands who grew up in the southern island of Okinawa do more housework for B. But Okinawa was separate from Japan for some time during its history (as an independent kingdom and as a U.S. occupied territory), and maintains a unique culture (Kerr 2000). The results suggest that they may be less traditional in their view towards gender roles.

6.4 Predicting Time Specific Birth in a Duration Model

In this section, we estimate the birth probability in an interval *j* given that they did not have a birth at the end of the last interval *j-1*. Hence it represents a time specific birth probability. In the discussions below, for brevity, we refer to time specific birth probability as birth probability, or the timing of birth. For each group, three sets of average marginal effects of birth probabilities are presented in separate columns: (1) a pooled duration model using the observed log of the husband's time in housework; (2) a pooled duration model using the predicted log of time in housework from the first stage and adjusting the standard errors of the second stage using a bootstrap method and clustering the errors by household; and (3) estimation of the marginal effects is the same as (2), but instead, we adjust the standard errors using the Murphy-Topel method discussed in section 5.5.1. All models assume a logistic distribution. While (1) does not control for the endogeneity of the husband's time in housework, (2) and (3) does so by using instrument variables. The average marginal effects for the first, second and third births are presented in Tables 6.4A, 6.4B and 6.4C, respectively. The STATA procedures to calculate the Murphy-Topel standard errors follow Hole (1996), while the procedures to calculate the standard errors of the marginal effects for (c) benefited from Sribner (1996)'s dlogit2 ado file.

Cameron and Trivedi (2009) argue that the standard errors are larger when they are clustered than when we treat the repeated observations by household as independent because a positive correlation in the error terms by household, especially for time invariant variables, is likely to cause the standard errors to be larger. As expected, we find that the bootstrap standard errors allowing correlation within households (column 2) are larger than the Murphy-Topel standard errors (column 3) in tables 6.4a, 6.4b and 6.4c. The bootstrap standard errors, clustered by household, are preferred over the Murphy-Topel standard errors because there is likely to be a downward bias in the error terms for the latter.

6.4.1 Group A: Predicting the Timing of the Birth of the First Child

The husband's time in housework does not have an effect on the timing of the first birth as shown in Table 6.4a. The duration of marriage has a positive effect on the timing of the first childbirth. Couples married for 4 years or less, and for 5 to 8 years face a 31.6 percent and 24.6 percent higher time specific birth probability, respectively in the duration models using instrumental variables (i.e. columns 2 and 3). The marginal effects are slightly larger in the IV model (columns 2 and 3) than when we use the observed husband's time in housework (column 1).

Only the marriage duration variables are significant in the first time specific birth probability. Other factors are insignificant.

6.4.2 Group B: Predicting the Timing of the Birth of the Second Child

In table 6.4b, we find that the husband's time in housework does not have an effect on the time specific birth probability in the model using observed time in housework (column 1) and in the model using the predicted time in housework from the first stage with bootstrap standard errors and Murphy-Topel standard errors (columns 2 and 3).

A couple faces a higher time specific birth probability if the first child is a one year old at *t*, controlling for other factors. The marginal effects are significantly larger using the IV approach at 26.7 percent (in columns 2 and 3) than when we use observed time in housework at 11.6 percent (column 1). When the first child is between the ages of 2-7, the probability is 17.4 percent higher. This suggests that once the first child is born, instead of spacing births, couples are likely to plan for another child immediately. Newman and McCulloch (1984) suggest that couples may shorten the inter-birth intervals because having children closer together may produce economies of scale and lower the cost of childcare.

Table 6.4a. Duration Model Predicting Time Specific First Birth for Group A

	Duration model (logit)	Duration with IV	Duration with IV
	(Cluster standard errors in parentheses)	(Bootstrap Cluster standard errors in parentheses)[c]	(Murphy-Topel standard errors in parentheses)
Endogenous variable			
Observed log husband's time in housework at t-2	-0.000999 (0.00747)		
Predicted log husband's time in housework at t-2		-0.0780 (0.0949)	-0.0780 (0.0611)
Duration variables			
Duration of marriage 0-4 at *t*	0.307*** (0.0936)	0.316** (0.142)	0.316*** (0.0737)
Duration of marriage 5-8 at *t*	0.232*** (0.0814)	0.246* (0.137)	0.246*** (0.0643)
Individual and household characteristics			
Age at marriage	-0.00293 (0.00777)	0.000531 (0.0118)	0.000531 (0.00787)
Lived with wife's mother at t-2	-0.00954 (0.0926)	-0.0238 (0.123)	-0.0238 (0.1108)
Lived with husband's mother at t-2	-0.0588 (0.0573)	-0.0846 (0.0840)	-0.0846 (0.0581)
Lived in metropolitan at t-2	-0.0742* (0.0430)	-0.0558 (0.0621)	-0.0558 (0.0402)
Log husband's annual earnings	0.00244 (0.00912)	-0.00285 (0.0313)	-0.00285 (0.0142)
Log husband's annual property earnings at t-2	0.00284 (0.00474)	-0.00162 (0.00852)	-0.00162 (0.0061)
Wife's years of work experience before marriage	0.00951 (0.0186)	0.00151 (0.0322)	0.00151 (0.0181)

Table 6.4a continued

	Duration model (logit)	Duration with IV	Duration with IV
	(Cluster standard errors in parentheses)	(Bootstrap Cluster standard errors in parentheses)[c]	(Murphy-Topel standard errors in parentheses)
Wife's years of work experience before marriage			
Square	-0.00134	-0.00100	-0.00100
	(0.00178)	(0.00368)	(0.0016)
Wife is 2 years or more older than husband	-0.101	-0.0717	-0.0717
	(0.0717)	(0.120)	(0.0748)
Husband is 10 years or more older than wife	-0.147	-0.155	-0.155
	(0.0944)	(0.182)	(0.0978)
<u>Education</u>			
Wife a university grad	0.0289	0.0382	0.0382
	(0.0594)	(0.0847)	(0.0491)
Husband a university grad	0.00128	0.0659	0.0659
	(0.0465)	(0.108)	(0.0650)
Wife a technical school, junior college	0.0248	0.00418	0.00418
	(0.0438)	(0.0704)	(0.0421)
Husband a technical school, junior college grad	-0.0508	-0.0538	-0.0538
	(0.0678)	(0.0922)	(0.0571)
Husband's father a university grad	0.0412	0.0173	0.0173
	(0.0472)	(0.0689)	(0.0447)
Husband's father a technical school, junior college grad	0.0247	-0.0160	-0.0160
	(0.0825)	(0.297)	(0.0854)
<u>Family Background</u>			
Husband non firstborn son * number of siblings	-0.00684	-0.0148	-0.0148
	(0.0268)	(0.0424)	(0.0231)
Wife non-first born daughter * number of siblings	0.0198	0.0315	0.0315
	(0.0278)	(0.0411)	(0.0263)
Husband is firstborn son * wife is firstborn Daughter	-0.0457	-0.0650	-0.0650
	(0.0591)	(0.0866)	(0.0529)

Table 6.4a continued

	Duration model (logit)	Duration with IV	Duration with IV
	(Cluster standard errors in parentheses)	(Bootstrap Cluster standard errors in parentheses)[c]	(Murphy-Topel standard errors in parentheses)
Region in which husband grew up during primary and junior high school[b]			
Husband grew up in Hokkaido	0.0378	-0.00839	-0.00839
	(0.0737)	(0.126)	(0.0662)
Husband grew up in Touhoku	0.106	0.105	0.105
	(0.0792)	(0.141)	(0.0739)
Husband grew up in Kita-kanto	-0.0511	-0.0905	-0.0905
	(0.172)	(0.198)	(0.1235)
Husband grew up in Tokai	0.0230	0.124	0.124
	(0.103)	(0.336)	(0.1167)
Husband grew up in Chubu	0.0582	0.0449	0.0449
	(0.0513)	(0.0675)	(0.0456)
Husband grew up in Shikoku	-0.00170	-0.246	-0.246
	(0.0942)	(0.335)	(0.2418)
Husband grew up in Kyushuu or Okinawa	0.0485	0.0246	0.0246
	(0.0660)	(0.0993)	(0.0592)
Observations	548	548	548
Correctly predicted	82.48%	82.12%	82.12%

Note: Dependent Variable: First Baby born in the last 12 months. Average marginal effects reported. Yearly dummies included.

[a] Shows highest educational attainment. Reference category for wife is middle school and high school graduates, and for husband is middle school and high school graduates.

[b] Indicates the region in which the husband grew up the longest during primary and junior high school. Reference category is Metropolitan Tokyo area (Shutoken), Metropolitan Osaka area (Kansai area) and Chugoku.

[c] 607 complete replication.

*** significant at 1%, ** significant at 5 %, * significant at 10%.

Table 6.4b. Duration Model Predicting Time-Specific Second Birth for Group B

	Duration model (logit)	Duration with IV	Duration with IV
	(Cluster standard errors in parentheses)	(Bootstrap cluster standard errors in parentheses[c])	(Murphy-Topel standard errors in parentheses)
Endogenous variable			
Observed log husband's time in housework at t-2	-0.00297		
	(0.00554)		
Predicted log husband's time in housework at t-2		0.0986	0.0986
		(0.0713)	(0.0682)
Duration variables			
1 year before first child born at *t-2* (or 1 year since first birth at *t)*	0.116*	0.267**	0.267**
	(0.0625)	(0.123)	(0.1245)
First child is age 0-5 at *t-2* (or 2-7 year since first birth at *t)*	0.288***	0.174*	0.174**
	(0.0481)	(0.0987)	(0.0895)
Individual and household characteristics			
Wife's age at first birth	-0.0159***	-0.0205***	-0.0205***
	(0.00426)	(0.00586)	(0.0066)
Lived with wife's mother at t-2	0.00352	0.00256	0.00256
	(0.0457)	(0.0549)	(0.0628)
Lived with husband's mother at t-2	-0.0244	0.0246	0.0246
	(0.0284)	(0.0466)	(0.0501)
Lived in metropolitan at t-2	-0.00602	0.0169	0.0169
	(0.0241)	(0.0313)	(0.0351)
Log husband's annual labor earnings at t-2	0.00365	-0.000398	-0.000398
	(0.00914)	(0.0126)	(0.0117)
Log husband's annual property earnings at t-2	-0.000774	-0.00164	-0.00164
	(0.00311)	(0.00345)	(0.0042)
Log of husband's annual state transfers at t-2	0.00553***	0.00496**	0.00496**
	(0.00200)	(0.00230)	(0.0028)
Wife's years of work experience before marriage	-0.0151	-0.0106	-0.0106
	(0.0104)	(0.0143)	(0.0124)

Table 6.4b continued

	Duration model (logit)	Duration with IV	Duration with IV
	(Cluster standard errors in parentheses)	(Bootstrap cluster standard errors in parentheses[c])	(Murphy-Topel standard errors in parentheses)
Wife's years of work experience before marriage squared	0.00136	0.000866	0.000866
	(0.00119)	(0.00175)	(0.0012)
First child is a girl * husband is firstborn son	0.00531	-0.0224	-0.0224
	(0.0224)	(0.0343)	(0.0359)
Wife is 2 years or more older than husband	0.0152	-0.0414	-0.0414
	(0.0472)	(0.0681)	(0.0705)
Husband is 10 years or more older than wife	-0.0651	-0.110	-0.110
	(0.0543)	(0.0796)	(0.0812)
Education			
Wife a university grad	-0.000714	-0.0373	-0.0373
	(0.0352)	(0.0479)	(0.0490)
Husband a university grad	0.0353	0.0745*	0.0745*
	(0.0257)	(0.0403)	(0.0435)
Wife a technical school, junior college	-0.0218	-0.0564	-0.0564
	(0.0248)	(0.0353)	(0.0390)
Husband a technical school, junior college grad	0.0187	0.0927	0.0927
	(0.0318)	(0.0639)	(0.0640)
Husband's father a university grad	-0.0111	-0.0468	-0.0468
	(0.0306)	(0.0430)	(0.0454)
Husband's father a technical school, junior college grad	-0.0725	-0.0867	-0.0867
	(0.0593)	(0.0738)	(0.0713)
Family background			
Husband went to private high school	-0.0622***	-0.0875***	-0.0875***
	(0.0231)	(0.0307)	(0.0349)
Husband non firstborn son * number of siblings	-0.0127	0.00302	0.00302
	(0.0114)	(0.0196)	(0.0179)

Table 6.4b continued

	Duration model (logit)	Duration with IV	Duration with IV
	(Cluster standard errors in parentheses)	(Bootstrap cluster standard errors in parentheses[c])	(Murphy-Topel standard errors in parentheses)
Wife non-first born daughter * number of siblings	-0.0305**	-0.0329*	-0.0329*
	(0.0151)	(0.0177)	(0.0191)
Husband is firstborn son * wife is firstborn daughter	-0.0582*	-0.0413	-0.0413
	(0.0301)	(0.0385)	(0.0413)
Region in which husband grew up during primary and junior high school [b]			
Husband grew up in Hokkaido	-0.0205	0.0427	0.0427
	(0.0425)	(0.0683)	(0.0711)
Husband grew up in Touhoku	-0.000902	-0.00793	-0.00793
	(0.0383)	(0.0428)	(0.0501)
Husband grew up in Kita-kanto	-0.0426	-0.0415	-0.0415
	(0.0564)	(0.0753)	(0.0656)
Husband grew up in Tokai	0.0789	0.0988	0.0988
	(0.0636)	(0.0820)	(0.0806)
Husband grew up in Chubu	0.00254	0.0441	0.0441
	(0.0260)	(0.0420)	(0.0454)
Husband grew up in Shikoku	0.00835	0.0209	0.0209
	(0.0534)	(0.0652)	(0.0667)
Husband grew up in Kyushuu	-0.0563*	-0.0536	-0.0536
	(0.0330)	(0.0363)	(0.0434)
Husband grew up in Okinawa	0.192***	0.0869	0.0869
	(0.0746)	(0.127)	(0.1464)
Observations	1,381	1,381	1,381
Correctly predicted	83.35%	83.13%	83.13%

Note: Yearly dummies included. Dependent Variable: Second Baby born in the last 12 months, average marginal effects reported.

[a] Shows highest educational attainment. Reference category for wife is middle school and high school graduates, and for husband is middle school and high school graduates.

[b] Indicates the region in which the husband grew up the longest during primary and junior high school. Reference category is Metropolitan Tokyo area (Shutoken), Metropolitan Osaka area (Kansai area) and Chugoku.

[c] 1,048 complete replications.

*** significant at 1%, ** significant at 5 %, * significant at 10%.

Table 6.4c. Duration Model Predicting Time Specific Third Birth for Group C

	Duration model (logit)	Duration with IV	Duration with IV
	(Cluster standard errors in parentheses)	(Bootstrap Cluster standard errors in parentheses[c])	(Murphy-Topel standard errors in parentheses)
<u>Endogenous Variable</u>			
Observed log husband's time in housework at t-2	0.000638 (0.00181)		
Predicted log husband's time in housework at t-2		0.0124 (0.0270)	0.0124 (0.0169)
<u>Duration Variables</u>			
1 year before second child born at *t-2* (or 1 year since second birth at *t)*	0.0261 (0.0197)	0.00963 (0.0423)	0.00963 (0.0270)
Second child is age 0-2 at *t-2 (*or 2-4 years since second birth at *t)*	0.0470*** (0.0134)	0.0306 (0.0388)	0.0306 (0.0240)
<u>Individual and household characteristics</u>			
Wife's age at first birth	-0.00271 (0.00223)	-0.00366 (0.00303)	-0.00366 (0.0019)
Lived with wife's mother at t-2	0.00582 (0.0134)	0.00705 (0.0152)	0.00705 (0.0106)
Lived with husband's mother at t-2	0.0227** (0.00955)	0.0284* (0.0164)	0.0284* (0.0108)
Lived in metropolitan at t-2	0.00848 (0.0108)	0.00956 (0.0126)	0.00956 (0.0077)
Log husband's annual labor earnings at t-2	0.000768 (0.00222)	0.000903 (0.00382)	0.000903 (0.0032)
Log husband's annual property earnings at t-2	-0.000181 (0.00146)	-0.000407 (0.00150)	-0.000407 (0.0011)
Log of husband's annual state transfers at t-2	0.00200*** (0.000759)	0.00161 (0.0012)	0.00161 (0.0008)

Table 6.4c continued

	Duration model (logit)	Duration with IV	Duration with IV
	(Cluster standard errors in parentheses)	(Bootstrap Cluster standard errors in parentheses[c])	(Murphy-Topel standard errors in parentheses)
Wife's years of work experience before marriage	0.00370	0.00419	0.00419
	(0.00459)	(0.0054)	(0.0031)
Wife's years of work experience before marriage squared	-0.000231	-0.000225	-0.000225
	(0.000493)	(0.00057)	(0.0003)
Wife is 2 years or more older than husband	0.0240	0.0257	0.0257
	(0.0250)	(0.0297)	(0.0149)
Husband is 10 years or more older than wife	0.0310	0.0293	0.0293
	(0.0196)	(0.0248)	(0.0152)
<u>Education</u>[a]			
Wife a university grad	0.00712	0.00661	0.00661
	(0.0169)	(0.0288)	(0.0138)
Husband a university grad	-0.0271**	-0.0273**	-0.0273**
	(0.0125)	(0.0129)	(0.0084)
Wife a technical school, junior college	0.0129	0.0124	0.0124
	(0.00976)	(0.0111)	(0.0068)
Husband a technical school, junior college grad	-0.0165	-0.0163	-0.0163
	(0.0119)	(0.0139)	(0.0088)
Husband's father a university grad	0.0139	0.00956	0.00956
	(0.0135)	(0.0183)	(0.0121)
Husband's father a technical school, junior college grad	-0.0416	-0.0395*	-0.0395*
	(0.0400)	(0.0231)	(0.0300)
<u>Family background</u>			
Husband went to private high school	-0.00390	-0.00399	-0.00399
	(0.0103)	(0.0111)	(0.0068)
Husband non firstborn son * number of siblings	-0.0146	-0.0209	-0.0209
	(0.0131)	(0.0181)	(0.0041)

Table 6.4c continued

	Duration model (logit)	Duration with IV	Duration with IV
	(Cluster standard errors in parentheses)	(Bootstrap Cluster standard errors in parentheses[c])	(Murphy-Topel standard errors in parentheses)
Wife non-first born daughter * number of siblings	-0.00174	-0.00329	-0.00329
	(0.00496)	(0.00614)	(0.0040)
Husband is firstborn son * wife is firstborn daughter	-0.00472	-0.00621	-0.00621
	(0.00461)	(0.00611)	(0.0124)
Region in which husband grew up during primary and junior high school [b]			
Husband grew up in Hokkaido	0.0390*	0.0486	0.0486*
	(0.0208)	(0.0313)	(0.0190)
Husband grew up in Touhoku	0.000955	0.00574	0.00574
	(0.0151)	(0.0201)	(0.0129)
Husband grew up in Kita-kanto	-0.0121	-0.0120	-0.0120
	(0.0198)	(0.0228)	(0.0147)
Husband grew up in Tokai	0.0520**	0.0480*	0.0480*
	(0.0211)	(0.0251)	(0.0164)
Husband grew up in Chubu	0.0147	0.0149	0.0149
	(0.0110)	(0.0123)	(0.0081)
Husband grew up in Shikoku	0.00632	0.00689	0.00689
	(0.0260)	(0.0288)	(0.0150)
Husband grew up in Kyushuu	0.0134	0.0204	0.0204
	(0.0124)	(0.0226)	(0.0140)
Husband grew up in Okinawa	0.0425	0.0459	0.0459
	(0.0314)	(0.0358)	(0.0329)
Observations	2,990	2,990	2,990
Correctly predicted	95.85%	95.85%	95.85%

Note: Yearly dummies included. Dependent Variable: Third Baby born in the last 12 months, average marginal effects reported.

[a] Shows highest educational attainment. Reference category for wife is middle school and high school graduates, and for husband is middle school and high school graduates.

[b] Indicates the region in which the husband grew up the longest during primary and junior high school. Reference category is Metropolitan Tokyo area (Shutoken), Metropolitan Osaka area (Kansai area) and Chugoku.

[c] 769 complete replications.

*** significant at 1%, ** significant at 5 %, * significant at 10%.

The older the age at first birth, the lower the second birth probability (by 2.05 percent). This suggests that when women entered into motherhood at a later age, they are less likely to plan for another child or they face a lower fecundity because they are older. This is as expected.

The husband being a graduate of a private high school reduces time specific birth probability by 8.75 percent (in columns 2 and 3). Hence, we find that family wealth and time specific fertility are inversely related.

When the husband is a university graduate, the couple faces a 7.45 percent higher probability in the IV model (columns 2 and 3). But the husband's annual labor and property income do not affect fertility. Education could be related to future income stability which in turn affects fertility.

The log of the annual government transfers has a positive effect on the timing of the second birth. A 10 percent increase in the log of the government transfers, keeping other factors constant, is likely to raise the time specific birth probability by 0.0496 percent in the Duration model with IV which is fairly small. Child allowances, which are likely to make up most of the government transfers, are provided to younger children in low and middle-income families. As discussed in section 5.2.3, in addition to central government policy, there are ward and city specific policies that expand the eligibility or levels of the child allowances. The regional dummies cluster prefectures by region and indicate where the husband grew up. Hence they do not control for ward and city levels where the couple currently resides. Since we controlled for the age of the youngest child and the husband's annual labor and property income, this result suggests that local government specific policies at the ward and city levels on child allowances could have a positive but small effect on the birth timing.

Duration since last birth, women's life cycle, family wealth, the husband's education and government transfer affect the timing of the second birth. In contrast, regional factors, the wife's education and the husband's labor and property income are not significant.

6.4.3 Group C: Predicting the Timing of the Birth of the Third Child

We find that the husband's time in housework does not affect the timing of the third birth probability in table 6.4c. Further, duration since last birth also does not impact the timing of birth.

Couples living with the husband's mother at *t-2* have a 2.84 percent higher time specific birth probability. This indicates the importance of the presence of help in the household with housework and childcare in determining the timing of the third birth. Given the amount of care required to look after three children, the presence of a mother in law seems to be a crucial factor in the fertility decision.

When the husband's father is a technical school or junior college graduate, the couple faces a lower time specific birth probability. Since this is a proxy for family wealth, this shows an inverse relation between family wealth and fertility. But the husband being a private senior high school graduate is not significant.

In contrast to B, when the husband is a university graduate, the time specific birth probability for the third child is lower. This means that the husband's education and time specific birth probability has a non-linear relationship. When the husband is more educated, the couple is likely to stop having children at two. The wife's education has no effect on fertility.

For the timing of the birth of the third child, the husband's education, family wealth and living with the husband's mother are important factors. Duration since last birth, women's life cycle, the husband's non-labor income and government transfers are not significant in fertility decisions.

6.5 Robustness Check

From 6.3.1, we found the variation in the husband's time in housework is affected by the age of the youngest child (equivalently the duration since last birth), and the hike in his contribution occurs when the first child is born. We want to make sure that the results obtained in the IV Probit in 6.2.2 (namely that the husbands time in housework at *t-2* has a positive effect on the second birth at *t*) is not driven by the fact that some couples in group B did not yet have their first child at *t-2*. These are couples whose first child is one years old at *t* (which is equivalent to one year before the first child is born at *t-2*). In other words, we want to make sure that the positive effect of the husband's time in housework on second birth probability is not driven by the kink in the husband's contribution caused by the birth of the first child.

Therefore a pooled IV Probit was estimated to predict the second birth by excluding these couples (i.e. the first child is one year old at *t*) shown in Table 6.5. We find that the husband's time in housework in the IV Probit excluding couples with a one-year old child at *t* has a positive effect on fertility and is significant at 5 percent. Further, the magnitude of the effect is larger than before. A 10 percent increase in the log of the husband's time in housework at *t-2* increases second birth probability by 3.12 percent at *t*. Hence, we can confirm that it has a significant on the second birth, even if we exclude those that did not have their first child at *t-2*.

Table 6.5. Predicting Second Birth in IV Probit Model¸ Excluding Couples Who Did Not Have Their First Child at T-2

	Group B excluding couples who did not have first child at t-2
Endogenous Variable	
Predicted log of husband's time in housework at t-2	0.312**
	(0.143)
Individual and household characteristics	
Wife's year born	0.0891
	(0.0674)
Wife's age at first birth	0.00972
	(0.0491)
Lived with wife's mother at t-2	0.0930
	(0.247)
Lived with husband's mother at t-2	0.0543
	(0.154)
Lived in metropolitan at t-2	0.0676
	(0.116)
Log husband's annual labor earnings at t-2	-0.00203
	(0.0373)
Log husband's annual property earnings at t-2	-0.00184
	(0.0139)
Log of husband's annual state transfers at t-2	0.0138
	(0.0103)
Wife's years of work experience before marriage	0.000608
	(0.0535)
Wife's years of work experience before marriage sq.	0.000796
	(0.00602)
First child is a girl * husband is firstborn son	-0.0408
	(0.110)
Wife is 2 years or more older than husband	-0.135
	(0.241)
Husband is 10 years or more older than wife	-0.320
	(0.252)
Education[a]	
Wife a university grad	-0.0648
	(0.174)
Husband a university grad	0.226*
	(0.126)

Table 6.5 continued

	Group B excluding couples who did not have first child at t-2
Wife a technical school, junior college	-0.159
	(0.120)
Husband a technical school, junior college grad	0.274
	(0.180)
Husband's father a university grad	-0.216
	(0.138)
Husband's father a technical school, junior college grad	-0.393
	(0.250)
Family Background	
Husband went to private high school	-0.299***
	(0.110)
Husband non firstborn son * number of siblings	0.00211
	(0.0670)
Wife non-first born daughter * number of siblings	-0.100
	(0.0671)
Husband is firstborn son * wife is firstborn daughter	-0.124
	(0.154)
Region in which husband grew up during primary and junior high school [b]	
Husband grew up in Hokkaido	0.0662
	(0.223)
Husband grew up in Touhoku	0.0693
	(0.175)
Husband grew up in Kita-kanto	-0.162
	(0.288)
Husband grew up in Tokai	0.406
	(0.321)
Husband grew up in Chubu	0.205
	(0.147)
Husband grew up in Shikoku	-0.0294
	(0.287)
Husband grew up in Kyushuu	-0.194
	(0.142)
Husband grew up in Okinawa	0.934
	(0.639)
Observations	1,202
Correctly predicted	80.70%

Note: Dependent Variable: Second Baby born in the last 12 months. Average marginal effects reported. Cluster standard errors in parentheses.

[a] Shows highest educational attainment. Reference category for wife is middle school and high school graduates, and for husband is middle school and high school graduates.

*** significant at 1%, ** significant at 5 %, * significant at 10%.

CHAPTER 7

CONCLUSION

The objective of this dissertation was two-folds, namely: to make a theoretical contribution by incorporating the role that the husband's contribution to unpaid work plays in women's fertility decisions; and to make an empirical contribution by examining whether the husband's time spent in unpaid work affect birth probabilities and time specific birth probabilities using Japanese time use panel survey data.

As a contribution to the theoretical literature, two areas of innovation were made in the Stackelberg fertility model. Firstly, we incorporated the role that the perception of social norms and the pressure to conform to these norms play in the husband's time spent in housework. Secondly, we developed how the husband's time contribution to housework increases his wife's demand for children in the subsequent period. In Japan, men tend to believe in gender assigned household responsibilities, and women are reluctant to have children because they do not receive adequate support from their husbands in housework (Cabinet Office 2007, Ehara 2004, Koba, Yasuoka and Urakawa 2009, Meguro 2004, National Institute of Population and Social Security Research 2003a, 2005). This situation can be characterized where the husbands believe that men do not need to be helpful in housework (i.e. low Z^e_{ht-1}) and a high level of pressure to conform to these norms (i.e. high α). The fertility model developed in the dissertation predicts that these factors are likely to lead to less time spent by the husband in housework and leading to women having a lower demand for children.

We relaxed one of the assumptions and examined the case when the intra-household transfers are endogenous. In two scenarios, namely the Gender Equality and Unequal Power and Lower Real Wage Rate scenarios, the effects of exogenous changes in Z^e_{ht-1} or α on the husband's time allocation and consumption decisions are the same as when the transfers were exogenous. Only in the special case of the Unequal Power and High Relative Wage-Price scenario, did we see that exogenous changes in Z^e_{ht-1} or α have no effect on the husband's time in housework and he does not spend any time in housework at all (and therefore causing no effect on the wife's demand for children). In this special case, our model reverts to the existing fertility literature which assumes that the husband provides no contribution to housework such as those by Becker (1991), Hotz and Miller (1988) and Willis (1979). Therefore, we found that the Stackelberg model with endogenous transfers developed in this section 4.6 is a general case fertility model in which the Becker-Hotz and Miller-Willis fertility model fits as a special case that occurs only under certain conditions outlined by the Unequal Power and High Real Wage Rate scenario.

Chapter 6 made an empirical contribution by estimating the effect of the husband's time spent in unpaid work on birth probabilities and time-specific birth probabilities. Unlike previous studies on fertility in Japan, we used a multivariate analysis and distinguished the factors affecting each birth order.
We examined first whether the husband's time spent in housework impacts birth probabilities by using the IV Probit model. We then analyzed whether the husband's time in housework affects the timing of birth by addressing time-specific birth probability using a duration model. In the IV Probit model, we found that women decide to have their first child even when their husbands are unhelpful, though this was only marginally significant. While this result contradicts our hypothesis, the descriptive statistics show that men spend little time in housework when they do not have children and the spike in men's contribution occurs only once the first child is born. Further, the difference in housework time men spent between those who had their first child and those that did not is small. Hence, the husbands' contribution to housework does not have an effect on women's decision to have the first child since they provide little support to begin with. Looking at second and third birth probabilities, we found that the husband's time spent in housework on a non-workday increases the birth probability for the second child, but it does not affect the birth probability of the third child. Therefore, our results indicate that our hypothesis that the husband's time in housework increases the birth probabilities is confirmed only for the second child. It also suggests that unhelpful husbands were weeded out before the decision to have the second child was made, which may explain why husband's time spent in housework is not significant in predicting the birth of the third child. After controlling for unobserved heterogeneity, the magnitude of the effect on the second birth probability became larger indicating that unobserved characteristics that are related to the husband's time in housework reduce the likelihood of the second child being born. A 10 percent increase in the husband's unpaid work

increases second birth probability by 3.6 percent. Hence, there is potential to increase the second birth probability if the husband is more helpful. As mentioned before, the overall fertility rate in Japan remains at 1.34 in 2007 (Ministry of Health, Labor and Welfare 2008). Efforts to raise the second birth probability are key to reversing the declining trend in fertility.

We found that the husband's time spent in unpaid work does not affect the timing of births in the duration model. Hence, the helpfulness of the husband is unlikely to shorten the inter-birth spacing. Therefore, while the husband's time in housework and childcare affect birth probabilities, it does not affect the time-specific birth probabilities. The result suggests that the husband's helpfulness affects the ultimate number of children women decide to have, but not the timing of births.

Living with the husband's mother had a positive impact on the timing of the third birth. This implies that the provision of unpaid work and childcare is an important consideration in fertility decisions. We also found some evidence that government transfers increase the time specific probability of the second birth in the duration model, although the marginal effects were small. The data does not provide sufficient information to link specific local policies to determine the level of government transfers given to families. There is room to evaluate the impact of local policies on fertility decisions in the future provided there is information about local government transfers and person level fertility. The Democratic Party that came into power in September 2009 has announced its plans to increase the child allowance by relaxing some the eligibility requirements, such as removing the income ceiling, or extending it to older children (Democratic Party 2009). This gives an opportunity for future research to evaluate the government policy change in child allowance on fertility in a few years' time. However, the results from this dissertation suggest that the impact of an increase in child allowance on fertility may be small.

As the Stackelberg model predicts, there is evidence that the husband's perception of gender norms such as the husband's childhood environment affect his time allocated to housework. We found that men who grew up in areas further away from the Tokyo and Osaka provide less support in housework. Initiatives to change the gender norms through media campaigns may contribute towards changing the existing perception of norms. The current government initiative called "ikumen project" which literally means men who raise their children, is encouraging men to participate in childcare (Ministry of Health, Labour and Welfare 2010). This is a welcome initiative if Japan is serious about addressing the declining fertility. Existing tax, social security and pension policies in Japan have been described as a “male breadwinner” system which imposes a large disincentive for women to work in the labor market (Osawa 2004). These policies are likely to reinforce the gender assigned roles and responsibilities and the division of labor in the home. A revision of these policies would be a significant step forward in changing gender norms.

Our findings challenge existing fertility models that assume that women shoulder the bulk of unpaid work and men do not provide any support in housework and childcare. Our findings support the arguments put forward by Folbre (1988), Ehara (2004) and Meguro (2004) that gender inequality in the home is a contributing factor in the declining fertility in Japan. Reversing these trends is even more important since Japan is unlikely to relax its tight immigration policy to address the problems stemming from the shrinking population and growing labor shortages.

APPENDIX A

ASSESSING IMPACT OF AN EXOGENOUS RISE IN THE WIFE'S WAGE RATE WHEN TRANSFERS ARE EXOGENOUS

To see the impact of an exogenous rise in the wife's wage rate at *t*, we totally differentiate the first order conditions 4.9-4.11 with respect to w_{wt}. Note that the husband's time in unpaid work in the first stage Z_{ht-1} is predetermined at *t* and hence is an exogenous variable.

$$U^{w}{}_{xx}\frac{\partial x_w}{\partial w_{wt}} - P_{wt}\frac{\partial \lambda_w}{\partial w_{wt}} = 0$$

$$U^{w}{}_{nn}\frac{\partial n}{\partial w_{wt}} - \frac{\partial \lambda_w}{\partial w_{wt}}(\psi - \varphi Z_{ht-1})\, w_{wt} - \lambda_w(\psi - \varphi Z_{ht-1}) = 0$$

$$P_{wt}\frac{\partial x_w}{\partial w_{wt}} - [T_w - (\psi - \varphi Z_{ht-1})n] + w_{wt}(\psi - \varphi Z_{ht-1})\frac{\partial n}{\partial w_{wt}} = 0 \quad \text{(A1)}$$

Expressing the totally differentiated first order conditions in a matrix gives,

$$\begin{bmatrix} U^{w}{}_{xx} & 0 & -P_{wt} \\ 0 & U^{w}{}_{nn} & -w_{wt}(\psi - \varphi Z_{ht-1}) \\ P_{wt} & w_{wt}(\psi - \varphi Z_{ht-1}) & 0 \end{bmatrix} \begin{bmatrix} \frac{\partial x_w}{\partial w_{wt}} \\ \frac{\partial n}{\partial w_{wt}} \\ \frac{\partial \lambda_w}{\partial w_{wt}} \end{bmatrix} = \begin{bmatrix} 0 \\ \lambda_w(\psi - \varphi Z_{ht-1}) \\ T_w - (\psi - \varphi Z_{ht-1})n \end{bmatrix} \quad \text{(A2)}$$

The Hessian determinant is given by,

$$|\mathrm{H}| = U^{w}{}_{xx}\left[w_{wt}{}^{2}\left(\psi - \varphi Z_{ht-1}\right)^{2}\right] + P_{wt}{}^{2}\ U^{w}{}_{nn} < 0 \quad \text{(A3)}$$

Since $U^{w}{}_{xx} < 0, U^{w}{}_{nn} < 0,$ the Hessian determinant is negative.

In order to find the effect of a rise in the wage rate on the wife's demand for children, using Cramer's rule, we substitute the right hand side vector in the second column of the left had side matrix in A2.

$$\frac{\partial n}{\partial w_{wt}} = \frac{1}{|H|}\begin{bmatrix} U^{w}{}_{xx} & 0 & -P_{wt} \\ 0 & \lambda_w(\psi - \varphi Z_{ht-1}) & -w_{wt}(\psi - \varphi Z_{ht-1}) \\ P_{wt} & T_w - (\psi - \varphi Z_{ht-1})n & 0 \end{bmatrix}$$

$$= \frac{1}{|H|}\{[U^{w}{}_{xx}(T_w - (\psi - \varphi Z_{ht-1})n)\, w_{wt}(\psi - \varphi Z_{ht-1})] + P_{wt}{}^{2}\lambda_w(\psi - \varphi Z_{ht-1})\} \lessgtr 0 \quad \text{(A4)}$$

As before, $(\psi - \varphi Z_{ht-1}) \geq 0$, $U^{w}{}_{xx} < 0$, and from 4.7, $T_w - (\psi - \varphi Z_{ht-1})n \geq 0$. Since the Hessian determinant is negative from A3, the first term is positive and it shows the income effect where a rise in the wage rate increases the wife's income which in turn, increases the demand for children. Since the Hessian determinant is negative, the second term is negative and it shows the substitution effect which gives the wife the incentive to work longer hours and reduce her time in childcare because the opportunity cost of childcare is now greater. The effect of a rise in wife's wages at *t* on the demand for children is indeterminate and it depends on whether the income effect dominates (increasing demand for children) or the substitution effect dominates (reducing the demand for children).

The effect of a wage increase on the wife's private consumption is,

$$\frac{\partial x_w}{\partial w_{wt}} = \frac{1}{|H|} \begin{bmatrix} 0 & 0 & -P_{wt} \\ \lambda_w(\psi - \varphi Z_{ht-1}) & U^{w}{}_{nn} & -w_{wt}(\psi - \varphi Z_{ht-1}) \\ T - (\psi - \varphi Z_{ht-1})n & w_{wt}(\psi - \varphi Z_{ht-1}) & 0 \end{bmatrix}$$

$$= \frac{1}{|H|} \left[-P_{wt}\lambda_w w_{wt}(\psi - \varphi Z_{ht-1})^2 + P_{wt}U^{w}{}_{nn}(T_w - (\psi - \varphi Z_{ht-1})n) \right] > 0 \qquad \text{(A5)}$$

Since the Hessian determinant is negative and $U^{w}{}_{nn} < 0$, the overall effect is positive. A rise in wage rate increases the opportunity cost of childcare, so the demand for private consumption increases and substitution away from having children (as see in the marginal rate of substitution 4.12).

The effect of a wage increase on the lagrangian multiplier is,

$$\frac{\partial \lambda_w}{\partial w_{wt}} = \frac{1}{|H|} \begin{bmatrix} U^{w}{}_{xx} & 0 & 0 \\ 0 & U^{w}{}_{nn} & \lambda_w(\psi - \varphi Z_{ht-1}) \\ P_{wt} & w_{wt}(\psi - \varphi Z_{ht-1}) & T_w - (\psi - \varphi Z_{ht-1})n \end{bmatrix}$$

$$= \frac{1}{|H|} \left(U^{w}{}_{xx}\left[U^{w}{}_{nn}\left(T_w - (\psi - \varphi Z_{ht-1})n\right) - \lambda_w w_{wt}(\psi - \varphi Z_{ht-1})^2\right] \right) < 0 \qquad \text{(A6)}$$

The overall effect is negative because a rise in the wife's wage rate increases her income and therefore reduces the marginal utility of income.

APPENDIX B

ASSESSING WHETHER THE WIFE'S DEMAND FOR CHILDREN IS CONCAVE OR CONVEX

In order to examine how the slope of the wife's demand for children changes as the husband's time in housework increases, we take the second derivative of $n(Z_{ht-1})$, which is $\frac{\partial^2 n}{\partial {Z_{ht-1}}^2}$.

Substituting Hessian determinant 4.16 into 4.17 gives:

$$\frac{\partial n}{\partial Z_{ht-1}} = \frac{[-{U^w}_{xx}{w_{wt}}^2\,(\psi - \varphi Z_{ht-1})\,n\varphi + {P_{wt}}^2\,\lambda_w w_{wt}\varphi]}{-\,[{U^w}_{xx}\,{w_{wt}}^2\,(\psi - \varphi Z_{ht-1})^2 + {P_{wt}}^2{U^w}_{nn}]} \qquad \text{A2.1}$$

Differentiate A2.1 with respect to Z_{ht-1} using the quotient rule yields:

$$\frac{\partial^2 n}{\partial {Z_{ht-1}}^2} =$$

$$= \frac{-[\,({U^w}_{xx}\,{w_{wt}}^2\,(\psi - \varphi Z_{ht-1})^2 + {P_{wt}}^2{U^w}_{nn}]{U^w}_{xx}\,{w_{wt}}^2 n\varphi^2 - [-{U^w}_{xx}{w_{wt}}^2\,(\psi - \varphi Z_{ht-1})\,n\varphi + {P_{wt}}^2\,\lambda_w w_{wt}\varphi]\,2{U^w}_{xx}{w_{wt}}^2\,(\psi - \varphi Z_{ht-1})\varphi}{[\,({U^w}_{xx}\,{w_{wt}}^2\,(\psi - \varphi Z_{ht-1})^2 + {P_{wt}}^2{U^w}_{nn}]^2}$$

The denominator is positive because it is a square of a negative number. For notational simplicity, set the denominator equal to A.

$$\frac{\partial^2 n}{\partial {Z_{ht-1}}^2} =$$

$$= \frac{-\,{U^{w2}}_{xx}\,{w_{wt}}^4\,(\psi - \varphi Z_{ht-1})^2 n\varphi^2 + {P_{wt}}^2{U^w}_{nn}{U^w}_{xx}\,{w_{wt}}^2 n\varphi^2 + 2{U^{w2}}_{xx}\,{w_{wt}}^4\,(\psi - \varphi Z_{ht-1})^2 n\varphi^2 - 2{U^w}_{xx}{P_{wt}}^2\,\lambda_w w_{wt}\varphi^2\,{w_{wt}}^2\,(\psi - \varphi Z_{ht-1})}{A}$$

$$= \frac{{U^{w2}}_{xx}\,{w_{wt}}^4\,(\psi - \varphi Z_{ht-1})^2 n\varphi^2 + {U^w}_{xx}\,{w_{wt}}^2 n\varphi^2 {P_{wt}}^2[{U^w}_{nn}n - 2\,\lambda_w w_{wt}\,(\psi - \varphi Z_{ht-1})]}{A} > 0 \qquad \text{A2.2}$$

$(\psi - \varphi Z_{ht-1})$ measures the wife's time required in childcare per child from (4.4), and it is clear that there cannot be a negative amount of time, hence $(\psi - \varphi Z_{ht-1}) > 0$. From (4.1), ${U^w}_{xx} < 0$ and ${U^w}_{nn} < 0$, so the overall sign is positive. This means that the demand for children increases, as the husband's time for housework rises, at an increasing rate. In other words, it is convex.

APPENDIX C

ASSESSING THE IMPACT OF A CHANGE

IN THE HUSBAND'S WAGE RATE

We look at the impact of a rise in the husband's wage rate by totally differentiating the first order conditions (4.27-4.29) with respect to w_{ht} giving the following equations.

$$U^h_{xx}\frac{\partial X_{ht-1}}{\partial w_{ht-1}} - \frac{\partial \lambda_h}{\partial w_{ht-1}} P_{ht-1} = 0$$

$$U^h_{nn}\frac{\partial n}{\partial Z_{ht-1}}\frac{\partial Z_{ht-1}}{\partial w_{ht-1}} + U^h_n\frac{\partial^2 n}{\partial Z_{ht-1}{}^2}\frac{\partial Z_{ht-1}}{\partial w_{ht-1}} - \alpha\frac{\partial Z_{ht-1}}{\partial w_{ht-1}} - \frac{\partial \lambda_h}{\partial w_{ht-1}} w_{ht-1} = \lambda_h$$

$$P_{ht-1}\frac{\partial X_{ht-1}}{\partial \alpha} + w_{ht-1}\frac{\partial Z_{ht-1}}{\partial \alpha} = T - Z_{ht-1} \quad \text{(A1)}$$

This can be expressed in matrix form below,

$$\begin{bmatrix} U^h{}_{xx} & 0 & -P_{ht-1} \\ 0 & U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n\frac{\partial^2 n}{\partial Z_{ht-1}{}^2} - \alpha & -w_{ht-1} \\ P_{ht-1} & w_{ht-1} & 0 \end{bmatrix}\begin{bmatrix} \frac{\partial X_{ht-1}}{\partial \alpha} \\ \frac{\partial Z_{ht-1}}{\partial \alpha} \\ \frac{\partial \lambda_h}{\partial \alpha} \end{bmatrix} = \begin{bmatrix} 0 \\ \lambda_h \\ T - Z_{ht-1} \end{bmatrix} \quad \text{(A3.2)}$$

The Hessian determinant is given by,

$$|H| = U^h{}_{xx}w_{ht-1}{}^2 + P_{ht-1}{}^2[U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n\frac{\partial^2 n}{\partial Z_{ht-1}{}^2} - \alpha] < 0 \quad \text{(A3.3)}$$

Since $U^h_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h_n\frac{\partial^2 n}{\partial Z_{ht-1}{}^2} - \alpha < 0$ from 4.22, the overall sign is negative.

The effect of a rise in the husband's wage rate on the husband's time in housework (Z_{ht-1}) is shown by,

$$\frac{\partial Z_{ht-1}}{\partial w_{ht-1}} = \frac{1}{|H|}\begin{bmatrix} U^h{}_{xx} & 0 & -P_{ht-1} \\ 0 & \lambda_h & -w_{ht-1} \\ P_{ht-1} & T - Z_{ht-1} & 0 \end{bmatrix}$$

$$= \frac{1}{|H|}[U^h{}_{xx}w_{ht-1}(T - Z_{ht-1}) + P_{ht-1}{}^2\lambda_h] \lesseqgtr 0 \quad \text{(A3.4)}$$

Since the Hessian determinant is negative from A3.3 and (T- Z_{ht-1}) ≥0 from the time constraint, the overall effect is indeterminate. A rise in the husband's wage rate reduces his time spent in housework from substitution effect (the second term in A3.4), but it could also increase his time due to an income effect (the first term in A3.4).

The effect of a rise in his wage rate on the husband's consumption (x_{ht-1}) is shown below.

$$\frac{\partial X_{ht-1}}{\partial w_{ht-1}} = \frac{1}{|H|} \begin{bmatrix} 0 & 0 & -P_{ht-1} \\ \lambda_h & U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n \frac{\partial^2 n}{\partial {Z_{ht-1}}^2} - \alpha & -w_{ht-1} \\ T - Z_{ht-1} & w_{ht-1} & 0 \end{bmatrix}$$

$$= \frac{1}{|H|}[(T - Z_{ht-1})P_{ht-1}(U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n \frac{\partial^2 n}{\partial {Z_{ht-1}}^2} - \alpha)] > 0 \quad \text{(A3.5)}$$

The overall sign is positive because the Hessian determinant is negative and $U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n \frac{\partial^2 n}{\partial {Z_{ht-1}}^2} -$ α) < 0 from 4.22. When the husband's wage rate is higher, this causes a substitution away from allocating time in housework leading to a higher demand for consumption, as shown in the husband's marginal rate of substitution 4.30.

The effect on the lagrangian multiplier is,

$$\frac{\partial \lambda_h}{\partial w_{ht-1}} = \frac{1}{|H|} \begin{bmatrix} U^h{}_{xx} & 0 & 0 \\ 0 & U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n \frac{\partial^2 n}{\partial {Z_{ht-1}}^2} - \alpha & \lambda_h \\ P_{ht-1} & w_{ht-1} & T - Z_{ht-1} \end{bmatrix}$$

$$= \frac{1}{|H|} U^h{}_{xx} \left[\left(U^h{}_{nn}\frac{\partial n}{\partial Z_{ht-1}} + U^h{}_n \frac{\partial^2 n}{\partial {Z_{ht-1}}^2} - \alpha\right)(T - Z_{ht-1}) - \lambda_h(w_{ht-1})\right] < 0 \quad \text{(A3.6)}$$

The overall sign is negative since $|H|<0$ and $U^h{}_{xx} < 0$. A rise in the wage rate increases his income. Consequently, the marginal utility of income is reduced.

APPENDIX D

JUSTIFICATION FOR USING A DURATION

MODEL TO PREDICT THE PRESENCE OF

LEFT AND RIGHT CENSORING

We refer to a “state” as the various stages of fertility, such as the state of having no child, having one child, or having two children, and we refer to duration as the time elapsed since the last birth. We use a proportional hazards model which assumes that there is an underlying hazard rate (or a probability) that is dependent on duration which is common to all persons, known as the baseline hazard rate (Hosmer *et al*, 2008). We define the duration to the next birth T_i to be the number of years it takes a woman *i* since her last birth for the next birth to occur. If she did not have an additional child, T_i is equal to infinity. We let *j* indicate the end of the interval in which a person is observed. We index the interval to a twelve-month period prior to the reporting period of the survey. The discrete interval hazard function h_{ij} is the conditional probability that a birth occurs in the interval *j* given that it had not occurred at the end of the previous interval *j-1* as shown in equation (A1) below. Using notations by Jenkins (2004: 71) and Hosmer *et al* (2008: 232), the discrete interval hazard function is,

$$h_{ij} = \Pr(j - 1 < T_i \leq j | T_i > j - 1) = \frac{S(j-1, X_i) - S(j, X_i)}{S(j-1, X_i)} \quad \text{(A1)}$$

Where $S(j, X_i)$ is the survival function for a woman *i* with characteristics X_i indicating the probability of remaining in the current state at the end of interval *j*. [67]

Right Censored Observations

For women whose transition to the next state is not observed in the sample (i.e. right censored), the probability of remaining in the current state is given by the survival function $S(j, X_i)$. A woman *i*’s.

67. Equation (A1) gives the probability of childbearing for a discrete interval, and not the probability at a particular instant.

contribution to the likelihood function L_i is given by the product of the probability of remaining in the spell at every interval until interval *j* (Jenkins 2004, p.71):

$$L_i = \Pr(T_i > j) = S(j, X_i) = \prod_{k=1}^{j}(1 - h_{ik}) \quad \text{(A2)}$$

Where *k* indexes the end of the interval.

<u>Uncensored Observations</u>

The contribution of women who had a birth in the interval *j* and hence whose transition to the next spell is observed in interval *j* is given below, and we define this observation to be uncensored (Jenkins 2004: 71).

$$L_i = \Pr(j - 1 < T_i \leq j) = h_{ij}S(j-1, X_i) = \left[\frac{h_{ij}}{1-h_{ij}}\right]\prod_{k=1}^{j}(1 - h_{ik}) \quad \text{(A3)}$$

We denote $c_i = 0$ if the spell is censored (i.e. transition to next state is not observed), and $c_i = 1$ if the observation is uncensored (i.e. transition to the next state is observed), then the likelihood function incorporating observations from the right censored sample (A2) and uncensored sample (A3) using Jenkins' notation (2004: 71) with *n* observations is:

$$L = \prod_{i=1}^{n}[\Pr(j-1 < T_i \leq j)]^{c_i}[\Pr(T_i > j)]^{1-c_i} = \prod_{i=1}^{n}\left[\left[\frac{h_{ij}}{1-h_{ij}}\right]\prod_{k=1}^{j}(1 - h_{jk})\right]^{c_i}\left[\prod_{k=1}^{j}(1 - h_{jk})\right]^{1-c_i} = \prod_{i=1}^{n}\left[\frac{h_{ij}}{1-h_{ij}}\right]^{c_i}\left[\prod_{k=1}^{j}(1 - h_{jk})\right] \quad \text{(A4)}$$

<u>Left Censored Observations</u>

In order to take into account that there is left censoring into the sample (when the beginning of the state, i.e. when she had a birth, is not observed in the data), we define the numbers of intervals that a person spent in the current spell before entering the sample as u_i .The contribution of a person with left censoring to the likelihood function is the probability of observing a birth conditional on surviving in the spell up to the end of interval $u_{i.}$ as shown in (A5) (Jenkins 2004):

$$L_i = \frac{\left[\frac{h_{ij}}{1-h_{ij}}\right]^{c_i}\left[\prod_{k=1}^{j}(1-h_{jk})\right]}{S(u_j, X_i)} \quad \text{(A5)}$$

The survival function at the end of interval u_i is:

$$S_j(u_j, X_i) = \prod_{k=1}^{u_i}(1 - h_{jk}) \quad \text{(A6)}$$

Jenkins (1995) show that substituting the expression (A6) into (A5) gives the following expression (A7), and this allows us to cancel the periods before the person entered the sample.

$$L_i = \frac{\left[\frac{h_{ij}}{1-h_{ij}}\right]^{c_i}\left[\prod_{k=1}^{j}(1-h_{jk})\right]}{\prod_{k=1}^{u_i}(1-h_{jk})}\mathrm{N} = \left[\frac{h_{ij}}{1-h_{ij}}\right]^{c_i}\left[\prod_{k=u_i+1}^{j}(1-h_{jk})\right] \quad \text{(A7)}$$

The result implies that it is possible to estimate the likelihood function by including only the intervals for which the data is observed, starting from the period the person entered the sample (Jenkins 2004).

Including these observations with the rest of the observations in (A4) gives the likelihood function of the whole sample with *n* observations below,

$$L = \prod_{i=1}^{n}\left[\frac{h_{ij}}{1-h_{ij}}\right]^{c_i}\left[\prod_{k=u_i+1}^{j}(1-h_{jk})\right] \quad \text{(A8)}$$

Where u_i gives the first interval the respondent was observed in the data.

Taking the natural logarithms of (A8) gives,

$$LogL = \sum_{i=1}^{n} c_i log\left(\frac{h_{ij}}{1-h_{ij}}\right) + \sum_{i=1}^{n}\sum_{k=u_i+1}^{j}\log(1-h_{jk}) \quad \text{(A9)}$$

We define a binary variable, y_{ik} indicating whether a person transitioned into the next spell during the interval (Jenkins 2004). Hence, $y_{ik} = 1$ if $c_i = 1$ for the interval $k = T_i$, and $y_{ik} = 0$ for all other cases. Substituting into (A9) gives an expression (Jenkins 2004: 72),

$$logL = \sum_{i=1}^{n}\sum_{k=u_i+1}^{j}\left[y_{ik}\log\left(\frac{h_{ik}}{1-h_{ik}}\right)\right] + \sum_{i=1}^{n}\sum_{k=u_i+1}^{j}\left[\log(1-h_{jk})\right] =$$

$$\sum_{i=1}^{n}\sum_{k=u_i+1}^{j}\left[y_{ik}\log h_{ik} + (1-y_{ik})log\,(1-h_{jk})\right] \quad \text{(A10)}$$

The equation can be estimated by making assumptions about its distribution such as a logistic distribution, or a complementary log-log function (Jenkins 2004).

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